POWER PLANT ENGINEERING

CONTENTS FOR THE MONTH OF

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VOLUME 44, NO. 4

Cover: Looking down on the feedwater heaters and evaporators in the turbine room of a large central station. Two high pressure and two low pressure extraction heaters and evaporators are shown in the view. (Photo, Hedrich-Blessing Studio.)

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EDITORIAL DIRECTOR

RALPH E. TURNER
EDITOR

ANDREW W. KRAMER
ELECTRICAL EDITOR

RICHARD H. MORRIS
ENGINEERING EDITOR

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WALTER PAINTER, Vice President
ARTHUR L. RICE, Treasurer
CHARLES S. CLARKE, Secretary

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ADVERTISING REPRESENTATIVES

CHICAGO: Charles S. Clarke, 53 W. Jackson Blvd., Chicago, Ill.
PHILADELPHIA: H. G. Wilds, 118 Penarth Road, Bala Cynwyd, Pa.
NEW YORK: John A. Kershaw, Graybar Bldg., New York, N. Y.
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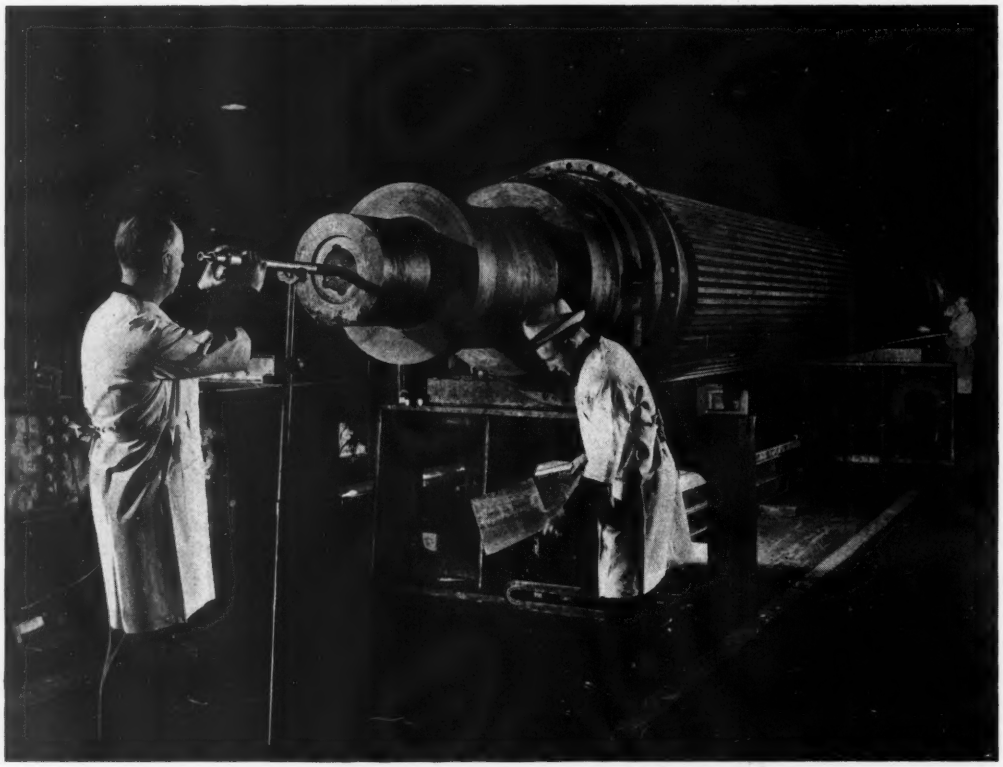


Looking For The Enemy

THE PERISCOPE, during the present European War, as in the past one, has been an important instrument in the wanton destruction of shipping by submarines. During February alone some 26 million dollars worth of shipping was destroyed through the agency of—the mighty periscope. Its war time importance needs no emphasis, its grim purpose, unfortunately is too well understood and established. ¶ The periscope, however, has a bright side as well as a grim one and its peace-time record is far more creditable. In the power industry, billions of dollars worth of machinery as well as countless lives have been protected through the interior inspection of large forged steel shafts by means of the periscope. One of these periscopes as set up in the shops of the Allis-Chalmers Co. at Milwaukee, Wis., is shown in the photograph above ready to spot the enemy in the form of cracks in the interior of the turbine shaft. This happens to be one of the largest generator shafts ever built. By means of the periscope every millimeter of its long interior is carefully examined for microscopic flaws. ¶ Periscopes of this type for the examination of parts not otherwise accessible are in general use throughout heavy industry. No turbine shaft can be permitted to leave the factory without such internal examination. Big ingots cool from the outside toward the center, driving imperfections to the bore; that is why if cracks exist, evidence of them will be found there. Now you cannot stick your head inside the bore to look for these cracks but the periscope can get into tight places and it can be lengthened or shortened like a telescope and it can be rotated through full 360 degrees, hence it makes an excellent instrument for locating such flaws and cracks. ¶ Even the Boulder Dam turbines owe to the periscope an amazing line scribbled by engineers at the bottom of one of its design records: "Expected life, 200 years."

WITH THE EDITORS

Comparison of Electric Rates

PUBLICATION of a new series of reports showing the electric rates charged in all the 48 states has been announced as being under way by the Federal Power Commission. It is stated that "These reports will permit a virtually current comparison of the electric rates prevailing in incorporated communities of all sizes, from 250 or more population, throughout the country. In presenting these bills," the reports state, "no attempt has been made to determine their reasonableness. Many factors operate to explain differences in the level of rates. Such factors, however, were not considered in preparing this report."

Every engineer knows that the working out of a practical rate schedule for electric service is an extremely complicated problem, involving in many cases elements that are not justly comparable with other local communities, to say nothing of comparison by states. Over long periods of operation, utility companies have built up special types of loads that have helped out the load factor and heat balance of their plants to such an extent that it has been possible to give other customers the benefits of reduced rates and still maintain overall profits. These companies have found that the type of industry prevalent in a community is an extremely deciding factor in the establishing of a rate schedule.

Many other factors such as money rates, local fuel prices, labor rates, density of population, use habits of customers, average punctuality in payment of bills, type and purity of water supply, average temperature of condensing water, character of earth affecting plant foundation costs and conduit work, city ordinances governing construction and service—all these factors and more have been known to affect the cost of supplying electricity to customers and it does not seem fair on the part of the Federal Power Commission to indicate that, with only a few controlling factors given, a just comparison of rates can be made, even though it is admitted that "no attempt has been made to determine their reasonableness."

Most certainly, customers should make just comparisons of the costs of electric services in comparable communities and between different types of plants and ownerships, but these comparisons are far from the simple listing of high and low costs per kilowatt-hour, as is intimated by the Federal Power Commission's tables. Inasmuch as supplying electric power to the public is a natural monopolistic enterprise, the public is entitled to a price that is fair for the conditions of the community and in line with modern technological development. At the same time the utility company is entitled to a profit sufficient to ensure the ability to raise capital for necessary expansion and continuity of service, and this requirement applies to publicly owned as well as privately owned systems.

It is to be hoped that those who have occasion to use these Federal Power Commission reports in comparing electric rates will do so with the understanding that the data given lack almost entirely the essential factors necessary for determining what rates should be in any particular community.

Pioneering Pains and Rewards

WHEN ten years ago Gilbert Station of the New Jersey Power and Light Co. was put into operation, it was among the first to employ a steam pressure of 1400 lb. per sq. in., 750 deg. F. temperature, so it may be classed as a station that has pioneered in modern steam generating practice. In a report recently prepared by the Utility Management Corp. covering the operating experiences over the first ten years the plant has been in service, some extremely interesting facts are revealed.

The difficulties surrounding the use of water in boilers seem to be definitely under control, for in this plant only a small percentage of the time out was chargeable to cleaning the internal heating surfaces, in fact only about half the time required for cleaning the gas side of the heating surfaces and about one fourth to one third the time for furnace cleaning. The auxiliaries to which the highest percentages of crippled hours were charged were the economizers and the induced draft equipment.

Water problems were foreseen and elaborate precautions were taken to preserve the purity of the boiler feedwater and salines and the excellent results speak well for the water treatment methods employed. While soot and dust accumulation on boiler tubes is an old problem, it was not until high rates of combustion and high furnace temperatures caused slag to form on the heating surfaces that this problem became serious. The conventional designs of soot blowers and steam lances used at regular intervals served very well for keeping loose dust off the tubes, but slag is an entirely different problem that requires not only specially designed tube blowing equipment but proper spacing and arrangement of tubes to prevent the stoppage of gas spaces. This whole problem has undergone investigation in recent years and is well on the way to a satisfactory solution.

Difficulties reported with the induced draft fans had to do principally with erosion which caused relatively rapid deterioration of the blades and fan lining. This problem also was brought on by operation at high combustion rates and is being met more satisfactorily in stations of recent design by the employment of dust collectors and fans of modern design.

Although this plant has been in operation ten years its original operating efficiency has been maintained throughout with an average economy of 11,684 B.t.u. per gross kw-hr. output and 12,538 B.t.u. per net kw-hr. Such excellent performance of a project containing many pioneering features is a tribute to the engineering skill of the designers of the plant and to those who have directed its operation.

As part of a $5,000,000 building program, Hartford's (Conn.) "Biggest Store" is completely rebuilt, air conditioned throughout and serviced by a well designed, modern power plant—a model of flexibility with a sensible and practical balance between purchased and generated electric power.

WHILE THE PRACTICABILITY and economy of high steam pressures have been conclusively demonstrated in utility and industrial plants, little has been done along this line in the so-called service plants for stores, hospitals, office buildings and institutions. Load conditions, limited capital and the general availability of purchased power are all contributing factors but undoubtedly the most important reason is lack of adequate engineering—the type of engineering that can lift the veil of precedent and prejudice to view the problem in its entirety and solve it with standard low cost equipment combined in such a way as to give the maximum economy with reliability and flexibility demanded by specific conditions.

Because of the successful way in which the power problem has been solved, the G. Fox & Co. department store at Hartford, Conn., is of unusual interest, not only to other department stores but to all service institutions where air conditioning and lighting loads are becoming of increased importance. While utilizing high pressure steam, the power plant consists of standard equipment arranged and combined to give a high degree of operating flexibility; economical provision for expansion to meet future and unexpected conditions; adequate provision for heat balance under a wide range of conditions; and, a sensible division of purchased and generated power.

General lighting and elevators are carried on purchased power. Due to the high lighting intensity and diversity factor on the elevators this load will remain reasonably constant at 2800 kw. throughout the year, an ideal purchased power load from the standpoint of both the customer and power company. On the other hand the air conditioning and

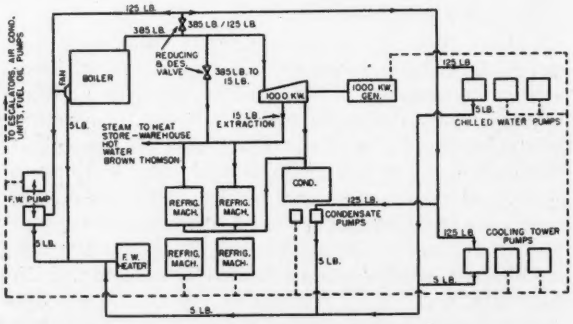
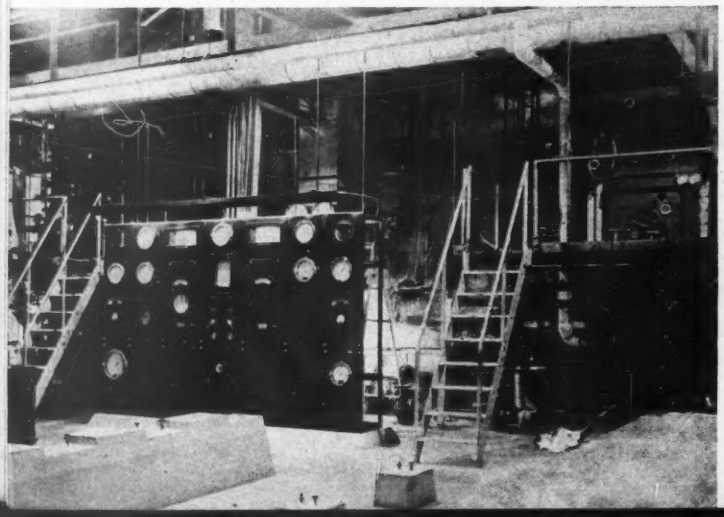


Fig. 2. Flow diagram. High pressure steam is used in the extraction-condensing main turbine. Steam extracted is used in the heating system and in the condensing turbines driving the air conditioning compressors. Power for the store lighting and elevators is purchased



auxiliary load is highly seasonal, an undesirable utility load in Hartford, yet a desirable condition for the private plant when the summer air conditioning can be balanced against the winter heating load.

The way in which this balance is accomplished is shown by the simplified flow diagram Fig. 2. Four steam pressure systems are used: full boiler pressure of 375 lb. ga., 600 deg. F. used in the main extraction-condensing turbo-generator; 125 lb. ga., 450

Fig. 1. The boiler fronts with one boiler directly behind the instrument panel, the other at the extreme right. The turbine-driven forced draft fan mounted directly on the furnace front is visible just below the walkway and the three oil burners just above. Space for a third boiler and pulverizers is available in the foreground where the foundations are already in place

The G. Fox Store Sets a New Standard

deg. F. supplied through reducing valves from the 375 lb. system and used for auxiliary drives; 15 lb. ga. extracted from the main turbine and used in the heating system in the winter and in low pressure condensing turbine drives on the air conditioning compressor in the summer; and the 5 lb. auxiliary exhaust system supplying the feed water heater.

Heat balance adjustment is provided by a combination of motor and turbine drives on both compressors and auxiliaries. Use of 125 lb. turbines on the auxiliary drives is an indication of the care given to first cost and economic considerations in the plant design. Although 375 lb. steam was available the additional cost of high pressure auxiliary turbines could not be justified.

The entire layout is of course built around the 1700 t. of refrigerating capacity (1100 t. turbine and 600 t. motor driven) used to air condition the entire selling space, 11 floors totaling 440,000 sq. ft., plus office space and two subbasements. Nor is this extensive use of air conditioning predicated on hopes for it is the result of practical experience with air conditioning the first floor and basement since

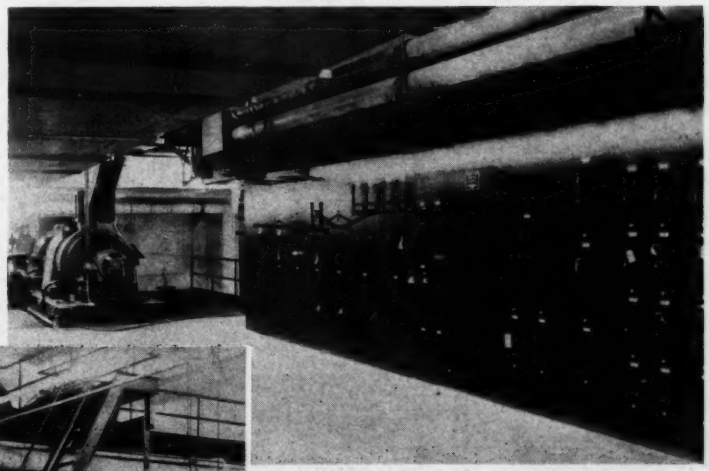


Fig. 3—The main turbo-generator and electrical distribution panel are located on a mezzanine floor which can be extended to provide for future generating units. The stairway in the lower photograph terminates at the far end of the switchboard, just to the right of the generator

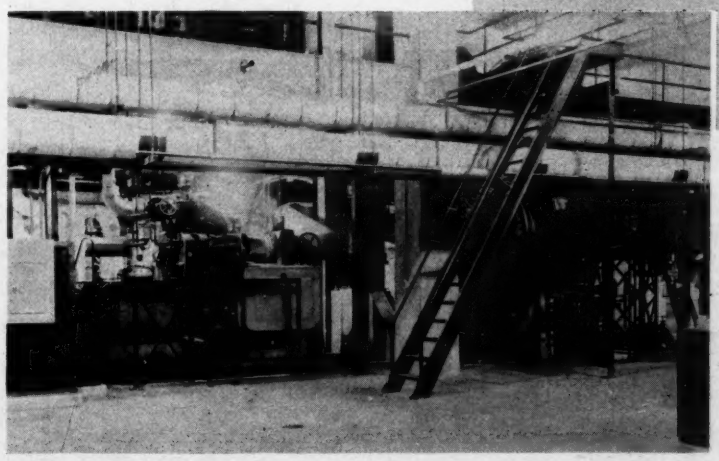


Fig. 4. The main and air conditioning turbines exhaust a single surface condenser with the circulating water cooled in a forced draft tower on the roof. The back of the electrical panel is visible in the upper left hand corner immediately above one of the turbine driven air conditioning units

1934 and is quite in line with what Hartford expects from its "Biggest Store."

G. Fox & Co. was started at 126½ Main Street in 1847 by two brothers, Gershon and Isaac Fox. In 1917 the old store was burned down but was immediately replaced with an 11 story structure by Gershon's son, Moses. Since then an almost continuous program of expansion and improvement has been followed under the direction of Moses, who died in 1937, his son-in-law and general manager George S. Auerbach, who died in 1930, and of recent years his daughter, Mrs. Auerbach.

In 1930 a nine story storehouse was built on the north side of Talcott St. and connected to the main building by a bridge and tunnel. In 1933, a $1,000,000 program was undertaken during which the store was modernized, escalators added on the lower floors and the first floor and basement air conditioned. Coming at the depth of the depression the expenditure of that amount was in the nature of a civic improvement even in Hartford where the large number of insurance companies and state employees give a steady purchasing power unequaled in the country.

No sooner was the $1,000,000 expenditure completed than a new $5,000,000 building program was undertaken to: practically double the floor space; completely air conditioning all selling floors; add escalators from the basement to the eighth floor; completely refinish the interior; and incorporate all features found desirable by 92 yr. experience in the Fox store as well as innovations discovered by an extensive investigation of 38 stores in 20 cities. The program was recently completed and the degree of success achieved may be judged by the fact that disinterested parties who know department stores say that it is now one of the finest in the country which rivals, if it does not actually excel Bullock's Wiltshire—of recent years the standard by which department stores are judged.

The first step in the program was a major achievement in itself, the second largest moving job ever undertaken in this country and the largest in New England. The 8 story, 8000 t. Brown Thompson store was moved south 137 ft. in 2 da. without disturbing the store activities nor interrupting water, phone or sewage services. In the space vacated a 12 story addition was built to the east of the original

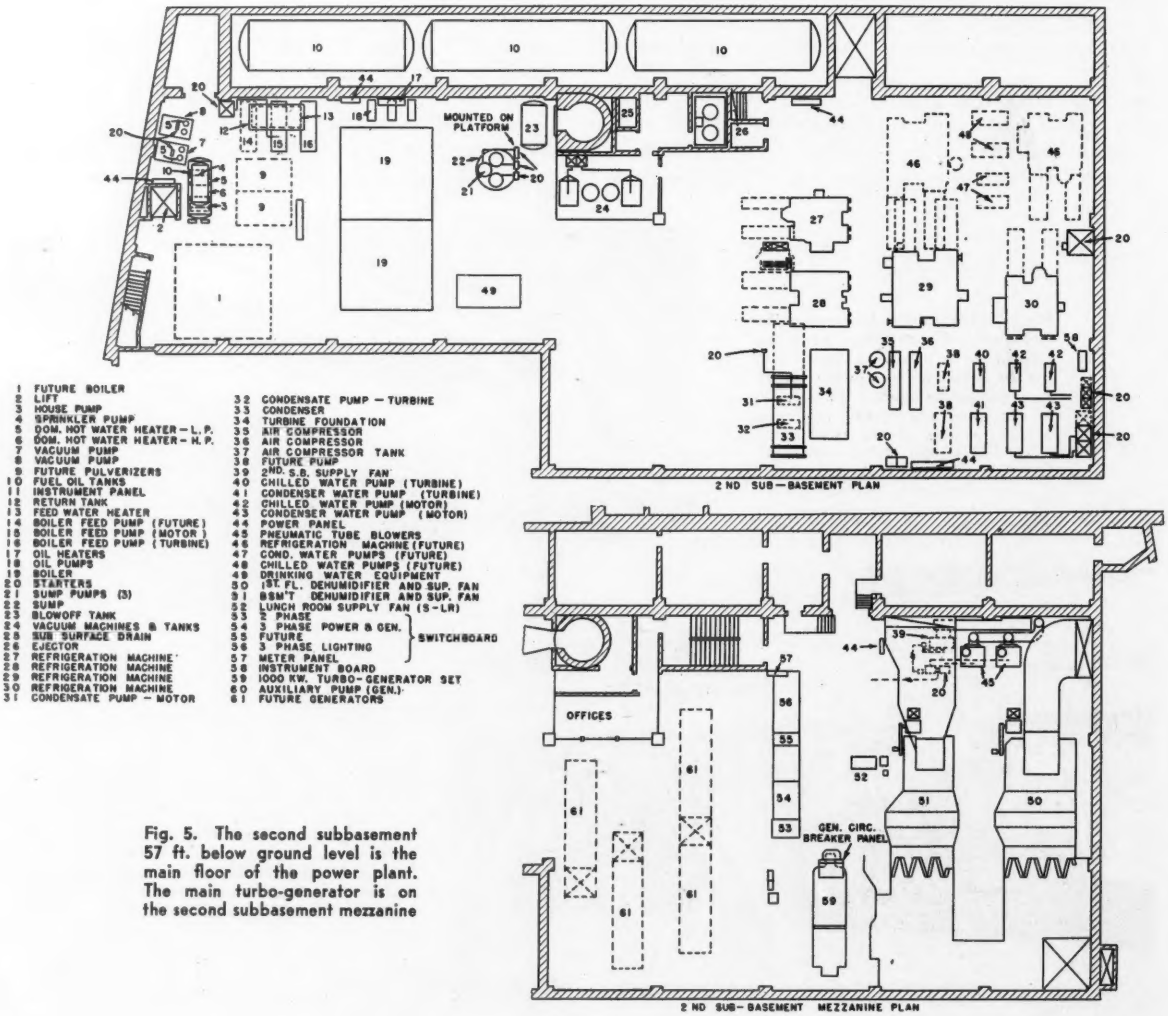


Fig. 5. The second subbasement 57 ft. below ground level is the main floor of the power plant. The main turbo-generator is on the second subbasement mezzanine

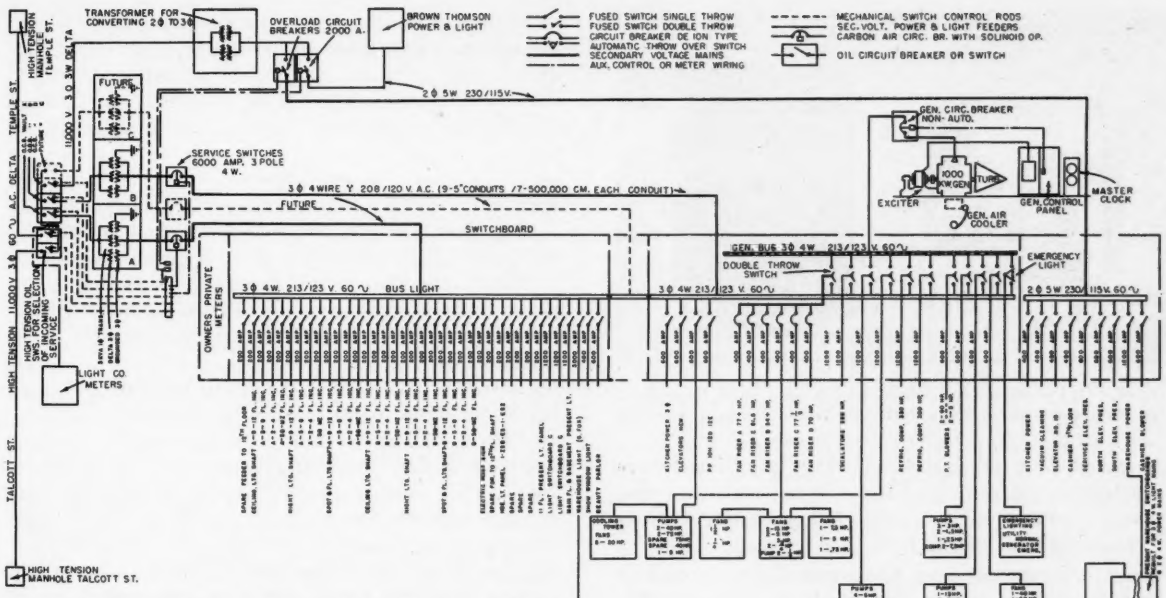

TRANSFORMER FOR CONVERTING 2φ TO 3φ
OVERLOAD CIRCUIT BREAKERS 2000 A.
BROWN THOMSON POWER & LIGHT
FUSED SWITCH SINGLE THROW
FUSED SWITCH DOUBLE THROW
CIRCUIT BREAKER DE ION TYPE
AUTOMATIC THROW OVER SWITCH
SECONDARY VOLTAGE MAINS
AUX. CONTROL OR METER WIRING
MECHANICAL SWITCH CONTROL RODS
SEC. VOLT. POWER & LIGHT FEEDERS
CARBON AIR CIRC. BR. WITH SOLINOID OP.
OIL CIRCUIT BREAKER OR SWITCH
HIGH TENSION MANHOLE TEMPLE ST.
TEMPLE ST.
FUTURE
11000 V. 3 Ø 3 W. DELTA
SERVICE SWITCHES 6000 AMP. 3 POLE 4 W.
2 Ø 5 W 230/115 V.
3 Ø 4 WIRE Y 208/120 V. A.C. (9-5" CONDUITS /7-500,000 CM. EACH CONDUIT)
FUTURE
SWITCHBOARD
GEN. CIRC. BREAKER NON-AUTO.
1000 KW GEN
TURB.
EXCITER
GEN. AIR COOLER
GEN. CONTROL PANEL
MASTER CLOCK
GEN. BUS 3 Ø 4 W 213/123 V. 60 ~
DOUBLE THROW SWITCH
EMERGENCY LIGHT
3 Ø 4 W. 213/123 V. 60 ~ BUS LIGHT
3 Ø 4W 213/123 V. 60 ~
2 Ø 5 W 230/115 V. 60 ~
OWNERS PRIVATE METERS
LIGHT CO. METERS
HIGH TENSION 11000 V. 3 Ø 60 ~ A.C. DELTA
HIGH TENSION OIL SWS. FOR SELECTING VARIOUS SERVICES
TALCOTT ST.
HIGH TENSION MANHOLE TALCOTT ST.

Fig. 6. Single line diagram of the complete electric system including purchased and generated power. The adjacent Brown-Thompson store building electric load, still 2 ph., is carried from the Fox store system. Most of the Fox store old 2 ph. equipment has been changed to 3 ph.

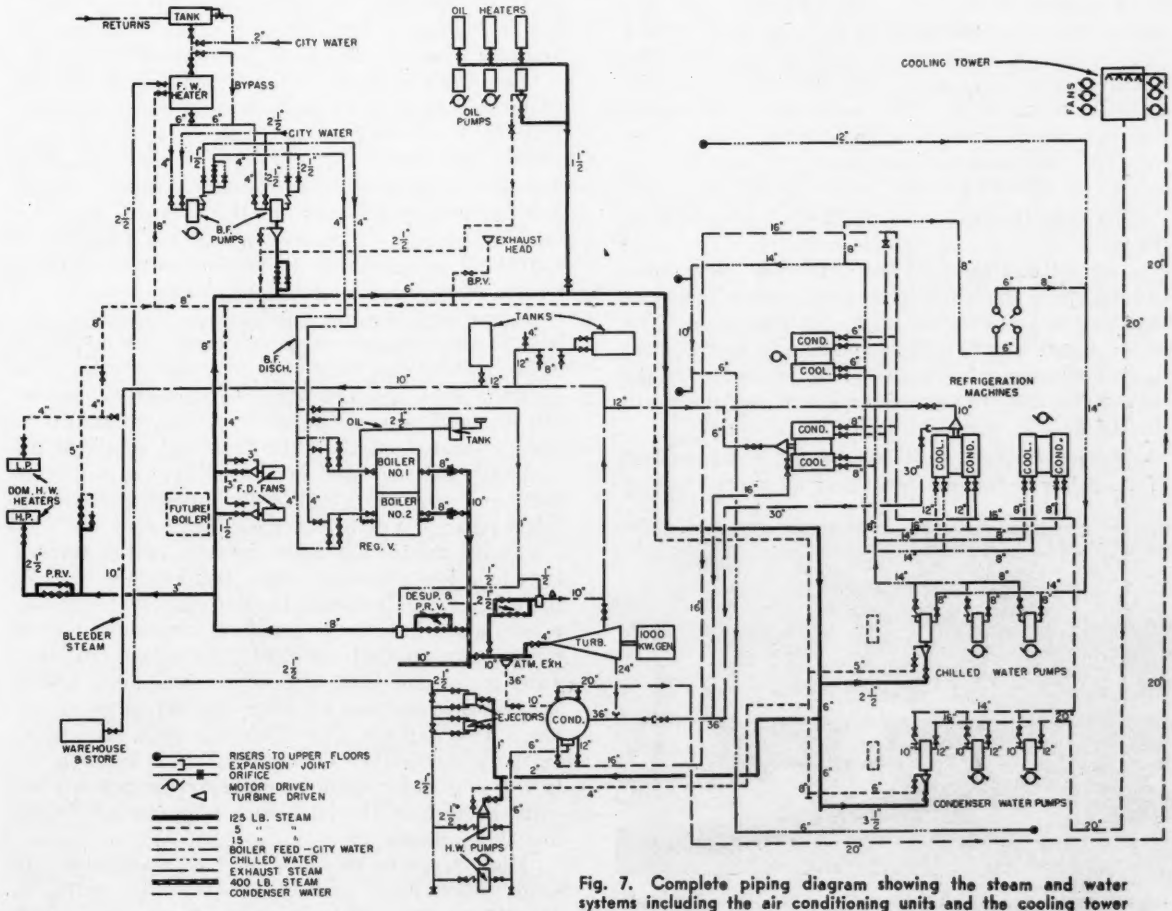


Fig. 7. Complete piping diagram showing the steam and water systems including the air conditioning units and the cooling tower on the roof. Fig. 2 is a simplification of this diagram

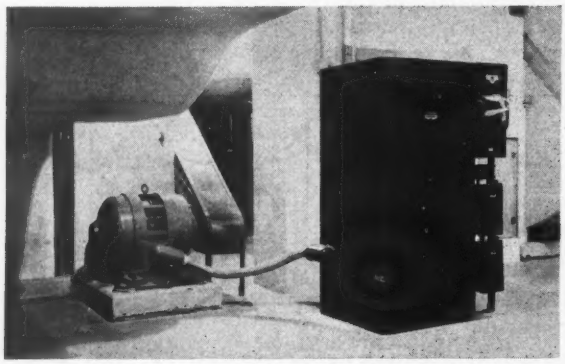


Fig. 8. Typical motor and starter arrangement used throughout. The starting current of the motors is limited to 100 amp. per step

11 story Fox store. Temporary partitions were erected one bay in from the original east wall and construction carried on behind these again without interfering with normal store operation.

In order to give an unbroken floor expanse in both the old and new sections with the columns all in line, it was necessary to remove seven of the original east wall columns which were out of line due to the angularity of the original lot boundary. This difficult problem was solved by joining the old and new structures by a triangular shaped section which extends from the basement to the top floor. New east wall columns and foundation are designed with a view to further extension of the building eastward. New escalators, 4 ft. wide from the basement to the sixth floor and 3 ft. wide from the sixth to the eighth floor are located in the center of the store, where the old and new buildings join and provide a capacity of 6000 persons per hr. in each direction.

The new structure provides 11 selling floors, from the basement to the tenth floor inclusive, with a total area of 440,000 sq. ft. The 11th floor is devoted to office space and a special display room which seats 1600 people and extends up to the 12th floor. The sub-basement and second sub-basement increase the total floor area to 586,444 sq. ft. exclusive of the store room and employees' lunchroom on the north side of Talcott Street.

The power plant is in the second sub-basement, 57 ft. below the street level and excavated out of

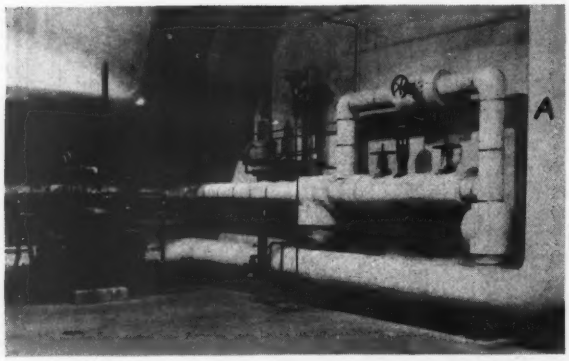


Fig. 9. High pressure steam line pressure reducing station and at the extreme left the high pressure drainage and return system.

solid rock. Inasmuch as this is some 12 ft. below the maximum flood mark, the 22 in. side walls and 24 in. floor is water proofed to a height of 40 ft. All drainage is handled from a special sump, Fig. 10, with the sump pump motors located on the level above.

A plan of the sub-basement and sub-basement mezzanine which constitute the power plant is shown by Fig. 5 and a complete piping diagram by Fig. 7. Steam at 375 lb. ga., 600 deg. F. is generated in two 60,000 lb. per hr. integral furnace boilers each with three burners. Each boiler has a turbine driven forced draft fan mounted directly on the boiler front as shown by Fig. 1.

At present fuel oil is being burned but provision has been made in the design to add pulverizers at any time fuel prices make this advisable. Pulverizer foundations are already in and space for a 250 t. coal bunker is available over the fuel oil storage tanks. These three 20,000 gal. tanks are located along the east wall as shown by Fig. 5. Turbine or motor driven fuel oil pumps, take their suction from the tanks and pump, through heaters directly above, to the boilers.

The boilers are operated automatically by a combustion control centralized on the seven panel board shown in Fig. 1. In addition to the controls, multipoint draft gages, steam flow, CO_2 and flue gas temperature recorders, the board incorporates a number of indicating pressure gages, temperature and pressure recorders and two electronic firing guides.

Feedwater is heated in a deaerating type feed heater and pumped to the boilers by two 126 g.p.m., 1226 ft. head, 3500 r.p.m. centrifugal boiler feed pumps, one driven by a 75 hp. motor, the other by a 70 hp. turbine. City water makeup is treated in a hot process softener but this is low due to the high percentage of returns which are pumped to a 2000 gal. storage tank above the feedwater heater by one of two condensate return units.

House service water is pumped by two 100 g.p.m., 200 ft. head pumps each driven by 15 hp., 1745 r.p.m. motors and located in the power plant. In addition there are two other centrifugal 50 g.p.m. 110 ft. head pumps driven by 5 hp., 1750 r.p.m. motors located on the 12th floor and so piped up that they may be used in three ways: to fill three 7500 gal. sprinkler tanks; to supply a auxiliary house tank; or pump to the cooling tower.

Two domestic hot water heaters of the storage type, one low pressure with a temperature control, the other a high pressure booster, are located in the power plant but the two motor driven circulating pumps, are located on the 12th floor. Drinking water is cooled by two 7½ t. refrigerating units, one on the 12th floor and one, shown by Fig. 11, in the power plant. Two 15 g.p.m. chilled water pumps, are located in the power plant. Compressed air is supplied by two 9½ by 9 in. single stage compressors equipped with silencers on the inlet, each compressor V-belted to a 30 hp. motor.

High pressure steam is used in a 1000 kw., 12 stage, 3600 r.p.m. turbine unit which drives a 213/123 v., 3 ph., 60 cycle, 0.80 p.f. generator with

List of Principal Power Plant Equipment

BOILERS AND STEAM PIPING

BOILERS—The Babcock & Wilcox Co. Two, integral furnace type, oil fired, 60,000 lb. per hr. (Max.) each; operating conditions 375 lb., 650 deg. F. t. t.

FUEL OIL BURNERS—The Babcock & Wilcox Co. Steam-mechanical atomizing system—three Cayamer burners per boiler, two 25,000 and one 15,000 lb. per hr. steam capacity.

BOILER FEED PUMPS—Ingersoll-Rand Co. Two, cap. each 126 g.p.m. at 1220 ft. head and 3500 r.p.m. One driven by 75 hp., 208 v., 3 ph., 60 cycle Crocker Wheeler motor, the other by a 70 hp., 125 lb., Type E. Terry turbine.

COMBUSTION CONTROL—Republic Flow Meters Co.

BOILER PANEL—Republic Flow Meters Co. Five panels arranged for combustion control and: Consolidated Ashcroft Hancock indicating pressure gages; Brown recording gages; and Ess Instrument Co. Hazegages.

FUEL OIL PUMPS—Northern Pump Co. Three, two size 4600-25 good for full load, one driven by a 3 hp., 690 r.p.m. C-W motor, the other by a Wing turbine through a Falk 2400 1635 gear. Third pump for ½ load capacity driven by a 1.5 hp. C-W motor.

FUEL OIL STRAINERS—Coen Co.

FUEL TANK INDICATORS—Pneumercator Co., Inc.

OIL HEATERS—Griscom-Russell Co.

FUEL OIL—Gulf Refining Co. No. 6 commercial fuel oil. A.P.I. 12.9, viscosity 160 S.S.F., at 160 deg. approx. 18,750 B.t.u. per lb.

WATER COLUMNS—Diamond Power Specialty Corp. Bicolor.

FEEDWATER REGULATORS—The Swartwout Co.

PUMP GOVERNORS—The Swartwout Co.

STOP AND CHECK VALVES—Schutte & Koerting Co.

LOW WATER CONTROL—Bailey Meter Co.

OIL CONTROL VALVES—Fisher Governor Co.

SAFETY VALVES—Consolidated Ashcroft Hancock Co.

FEEDWATER HEATER—Cochrane Corp. Deaerating type.

WATER SOFTENER—Cochrane Corp. Hot process lime and soda ash.

CONTINUOUS BLOWDOWN—Cochrane Corp.

DRIP PUMP—Ingersoll-Rand Co. One, cap. 40 g.p.m. at 48½ ft. head, driven by a G-E 1 hp., 1750 r.p.m. motor with Cutler-Hammer float switch control.

DRIP SYSTEM VALVES—Henry Vogt Machine Co. Forged valves on 375 lb. drip system.

REDUCING VALVES AND DESUPERHEATERS—The Swartwout Co.

VALVES—Reading, Pratt & Cady—all valves except as noted.

TRAPS—Kaye & MacDonald. K-Master.

TURBINES AND SWITCHBOARD

TURBO-GENERATOR—Terry Steam Turbine Co. Type F12, 3600 r.p.m., 12 stage turbine driving a Crocker Wheeler 1250 kv-a., 3 ph., 60 cycle, 213/123 v. generator. Throttle conditions 375 lb. ga., 650 deg. F., condensing (27 in.) with automatic extraction at 15 lb. ga. up to 24,000 lb. per hr. Direct connected exciter C-W Type CD, 14 kw., 125 v., 112 amp.

CONDENSER—Condenser Service & Eng. Co. 4000 sq. ft. of surface.

CONDENSER WATER PUMPS—Ingersoll-Rand Co. Three, 2240 g.p.m., 100 ft. head, 1750 r.p.m. each. Two driven by 75 hp. C-W motors, one by a 70 hp. Terry 125 lb., 5 lb. b.p. turbine. (These also supply water to the refrigeration condensers—see Fig. 7.)

HOTWELL LEVEL CONTROL—The MacAlear Co.

HOTWELL PUMPS—Ingersoll-Rand Co. Two, cap. 85 g.p.m. at 95 ft. and 1750 r.p.m. One driven by a 5 hp. C-W motor, the other by a Terry 125 lb., 5 lb. b.p. turbine.

CONDENSER AIR PUMP—Condenser Service & Eng. Co. Two stage with Jenkins steam valves.

INDICATING THERMOMETERS—Instrument Service Co.

ATMOS. RELIEF VALVE—Cochrane Corp., Multiport.

GENERATOR AIR COOLER—Minneapolis-Honeywell Regulator Co.

TURBINE OIL COOLER—Andale Eng. Co.

CENTRIFUGE—Goulds Pumps, Inc. Hydrol unit for turbine oil.

PRESSURE GAGES—Consolidated Ashcroft Hancock Co.

TACHOMETER—James G. Biddle Co.

GENERATOR FIELD RHEOSTAT—Crocker Wheeler Electric Mfg. Co.

VOLTAGE REGULATOR—Westinghouse Electric & Mfg. Co. Type AE1.

SWITCHBOARD—The Plainville Elec. Prod. Co.

CIRCUIT BREAKERS—Westinghouse Electric & Mfg. Co. Deion.

MOTOR DISCONNECT SWITCHES—Westinghouse Electric & Mfg. Co.

ELECTRIC CABLE—Habershaw Wire & Cable Co.

CONDUIT—Walker Bros.

SWITCHBOARD INSTRUMENTS—Westinghouse Electric & Mfg. Co.

WATTHOUR METERS—Sangamo Electric Co.

DEMAND METERS—Westinghouse Electric & Mfg. Co.

AIR CONDITIONING AND HEATING

AIR CONDITIONING UNITS—Carrier Corp. Four, centrifugal type; one 300 t. driven by a 345 hp., 4260 r.p.m., 15 lb. condensing, 4 stg. Terry turbine; one 800 t. driven by a 1040 hp., 4336 r.p.m., 15 lb., condensing, 4 stg. Terry turbine; two 300 t. driven at 4320 r.p.m. by a 350 hp., 1750 r.p.m. C-W motors through Terry gears.

COPPER EXPANSION JOINTS—Kupperman Co.

COOLING TOWER—The Marley Co. Forced draft type with five 132 in. propeller type fans each driven through a gear reducer by a 20 hp. C-W motor. (Space provided for sixth fan.) Each fan moves approximately 180,000 c.f.m. Tower capacity 10,700 g.p.m., cooling from 102.2 to 86.9 deg. F. at 75 deg. F. wet bulb.

CHILLED WATER PUMPS—Ingersoll-Rand Co. Two, cap. 1400 g.p.m., 100 ft. head, 1750 r.p.m. each. One driven by 40 hp. C-W motor, one by a Terry 125 lb., 5 lb. b.p. turbine.

PUMP CHECK VALVES—The Williams Gauge Co.—Hagan 10 in.

AIR WASHERS—Carrier Corp.

FANS—B. F. Sturtevant Co.

HEATING COILS—Busch Mfg. Co.

TEMPERATURE CONTROLS—Johnson Service Co.

AIR FILTERS—Staynew Filter Co.

CONDENSATE RETURN UNITS—Nash Eng. Co. Two receiver sets each with two Jennings Size N952 pumps with a capacity of 1735 g.p.h. (6500 sq. ft. of radiation), at 20 lb. discharge press. Each pump driven by a 5 hp. C-W motor.

MISCELLANEOUS EQUIPMENT

DRINKING WATER PUMP—Ingersoll-Rand Co. Cap. 20 g.p.m. at 80 ft. head, driven by a C-W 1½ hp., 1750 r.p.m. motor.

DRINKING WATER COOLING UNIT—Frick Co. (top floor) Automatic Freon unit with Penn. Elec. Switch Co. control and driven by 7½ hp. C-W motor. (In power plant.) One compressor 4 by 4 in. 2 cyl. driven through V-belts by a G.E. 7½ hp., 1750 r.p.m. motor.

SUMP PUMPS—Yeomans Bros. Co., Two.

STORAGE HEATERS—Whitlock Coil Pipe Co. Two, one low pressure, one hp. booster, both equipped with Consolidated-Ashcroft Hancock-indicating thermometers and Julian d'Este thermostatic control valves.

HOT WATER CIRCULATOR—Ingersoll-Rand Co. One, cap. 10 g.p.m., at 22 ft. head, driven by a ½ hp. C-W 1750 r.p.m. motor.

HOUSE PUMPS—Ingersoll-Rand Co. (In power plant) two, capacity each 100 g.p.m. at 200 ft. head, 1745 r.p.m. driven by C-W 15 hp. motors. (Top floor) two, cap. each 50 g.p.m. at 110 ft. head, driven by 5 hp., 1750 r.p.m. C-W motors.

HOT WATER METER—Hersey Meter Co.

VACUUM CLEANING SYSTEM—Spencer Turbine Co., driven by 25 hp., 1750 r.p.m. C-W motor.

RECORDING THERMOMETERS—Brown Instrument Co. remote reading resistance type with recorders in chief engineer's office.

PUMPS—All Ingersoll-Rand Co. unless otherwise noted.

AUXILIARY MOTORS—All Crocker Wheeler Electric Mfg. Co. 208 v., 3 ph., 60 cycle motors unless otherwise noted.

MOTOR CONTROLLERS—Cutler-Hammer, Inc. Magnetic controllers with starting current limited to 100 amp. per step. (See Fig. 8 for typical arrangement.)

SAFETY SWITCHES—Westinghouse Electric Mfg. Co.

AIR COMPRESSORS—American Air Compressor Co. Two, 75-100 lb. pressure. Size 9½ by 9 in. Type AF1, each V-belted to a 30 hp. C-W 1750 r.p.m. motor.

COMPRESSOR SILENCERS—Maxim Silencer Co.

AIR RECEIVERS—Quaker City Iron Works.

the generator voltage automatically controlled by a voltage regulator. This is a condensing turbine arranged for automatic extraction of up to 24,000 lb. per hr. of 15 lb. ga. steam. During the winter this bled steam is used in the heating system; during the summer it is used in two low pressure turbines driving two of the air conditioning compressors.

These two turbines, as well as the main turbine, exhaust to a single 4000 sq. ft. surface condenser mounted at one side of the turbine foundation with a side inlet as shown by Fig. 4. This has a 2-stage steam jet vacuum pump and two hotwell pumps one motor the other turbine driven.

Circulating water for the steam and air conditioning condensers is pumped to a forced draft cooling tower on the roof by four 2240 g.p.m., 100 ft. head, three driven by 70 hp. motors, and one by a 70 hp. turbine. The tower, said to be the largest of this type north and east of Texas, is 40 ft. wide, 80 ft. long and 40 ft. high and has a cooling capacity of 10,700 g.p.m. over a range of from 102.2 to 86.9 deg. F. at 75 deg. F. wet bulb. As shown by the photograph at the head of this article this tower has provision for six fans, three on each side but at present only 5 are installed. Each fan of the 132 in. propeller fans has a capacity of 180,000 c.f.m. of air and is driven by a two speed 20 hp. motor, through a gear reducer, at 256/176 r.p.m.

Auxiliary Steam

Two 1400 g.p.m. 100 ft. head pumps for circulating the chilled water from the refrigerating units to the air conditioning units on the various floors are installed adjacent to the circulating water pump. One is driven by a 40 hp. motor, the other by a 40 hp. turbine.

Steam for the auxiliary drives is supplied through a pressure reducing valve station from the 375 lb. system. All steam auxiliaries operate at 125 lb. ga., 100 deg. F. superheat and exhaust to the 5 lb. ga. system supplying the feedwater heater. The motors are all 213 v., 3 ph., 60 cycle, with safety switches and magnetic starters which limit the starting currents to 100 amp. per step. Figure 8 is typical of the motor and starter cubicle arrangement used throughout.

The air conditioning load is carried by four centrifugal units totaling 1700 t. Two of these, one 800 t., the other 300 t., are driven by 4 stage, 15 lb. ga. condensing geared turbines rated at 1040 hp., 4336 r.p.m. and 345 hp., 4260 r.p.m. respectively. The other two units, rated at 300 t. each, are driven by 350 hp., 1750 r.p.m. motors through gears.

All four units are located on the second subbasement or main power plant floor with sufficient floor space available for two additional units. The main turbo-generator, switchboard, engineer's office and two dehumidifier units are located on the mezzanine floor which can be extended two bays as shown by Fig. 5, to accommodate future units. The two dehumidifier and fan units in the power plant take care of the main floor and basement. All piping is carried in three pipe shafts which extend the full height of the structure. With one or two exceptions, made necessary by the location of the two restaurant kitchens, the following arrangement is typical of all floors.

Floor Arrangement

Each floor has four fan rooms with air filters, both heating and cooling coils and inlet louvers from both the inside and outside. These four units, about equidistant from each other, discharge to a plenum chamber at the ceiling and extending almost entirely around the perimeter of the floor. Outlet louvers at approximately 10 ft. intervals control the distribution of air. The return is through louvers at the side of the fan rooms and also through plenum chambers incorporated in the metal lath ceiling construction of two central bays. A fifth fan room on each floor houses the exhaust fan. Fan capacities are sufficient to give from 4 to 6 air changes per hour and about 70 per cent of the air is recirculated. In summer temperatures are maintained within 8 to 12 deg. of the outside temperature with the relative humidity about 10 per cent lower with a minimum of 50 per cent.

Electrical connections from the utility's double 11,000 v., 3 ph., 60 cycle services through to the plant switchboard are shown by Fig. 6 and the switchboard itself by Fig. 3. The store originally had a 2 ph., 5 wire system which was largely eliminated during the construction period and a new 3 ph., 208/120 v. 4 wire system installed. Two phase motors larger than 25 hp. were not changed, however, and the short bus shown at the right of Fig. 6 supplies what remains of the 2 ph. load which is carried by a bank of Scott connected transformers. Two phase power and light is also supplied through these same transformers for the adjacent Brown-Thompson store building.

Operation and Design

General lighting and the elevator load carried on the utility system are connected to the bus at the left, fans, escalators and auxiliaries shown in the center are normally carried on the generator bus but can be switched over to the purchased power line if desires. Of these only the emergency lighting system has an automatic throwover. The main switchboard is equipped with circuit breakers and dead front switches, watthour meters and demand meters.

The power plant operating force, in addition to chief engineer consists of: one clerk; one assistant engineer; two oilers; and four firemen, one of whom acts as relief man.

Riggs, Distler & Co., Inc., of Philadelphia, were the mechanical and plumbing contractors and H. M. Mandley of Hartford the electrical contractor. Design and engineering of the power plant, air conditioning system and mechanical details of the installation was done by Edward E. Ashley, consulting engineer of New York, with W. D. Christie in direct charge as the engineer's representative during construction.

Part II. Having dealt in Part I, published in the March issue, with the occurrence of silica in nature and its action in the operation of steam boilers, the present article describes a treatment designed to remove silica from boiler waters and prevent scale formation on turbine blades.

Silica in Boiler Feedwater

By

WILLIAM F. PETERS, JR.* and DR. W. D. TURNER†

RECOGNIZING the detrimental effects of silica, and that present methods were not designed especially to remove it, the writer in 1930,[15] set about the development of such a method. A number of incidents brought the point more forcibly to the fore. In particular, in one plant where the water was not metered, 75,000 gal. of water was thought to be the make-up water used. A new treatment designed for this quantity made the water in the boiler soft, but the water coming from the lime and soda softener, before entering the boiler, was hard. Previously to the new treatment, the boiler had been taken off the line every seven weeks and washed out. At the end of fourteen weeks of service it has been turbined. At the end of the first seven weeks of this new treatment the boiler was opened and the old scale seemed to be peeling off. It was then turbined and replaced on the line. Thereafter, it was opened every seven weeks, but not turbined again for a year.

Later a meter was installed and it was discovered that instead of treating 75,000 gal. daily, the average was 156,000 gal. daily. When the treatment was modified to conform, by calculation, to this volume, it at once made the water from the softener soft, but scale was found to be forming again in the boiler, and alkalinities rose to such an extent that excessive corrective treatment was necessary to prevent caustic embrittlement. Upon this disclosure, the partial treatment was re-established and the results were once more a clean boiler and low alkalinity.

An analytical study of the two treatments showed that the partial method of treatment had prevented silicate scale from forming, whereas the complete treatment had not. It showed further that the partial treatment had removed calcium from the feedwater, but had left magnesium in. It showed further that with partial treatment the sludge from the boiler was high in magnesium, and contained about 4 per cent silica, whereas the complete treatment created a hard scale high in calcium and containing about 6 per cent silica. Furthermore, there was no detectable silica in the boiler water under the partial treatment method, whereas, under the old standard method there was never less than 40 ppm.

The results were so compelling that further tests were at once started in a series of beakers so arranged that treatment could be accomplished in stages as the water flowed from beaker to beaker. Thus the nature of the sludge at each stage of treatment could be determined. As was expected, the first beaker sludge contained considerable calcium and carbon dioxide, while the last was high in magnesium and water of hydration. The unexpected was that the silica on plotting the results (Fig. 1) had a curve like the magnesium.

These results were communicated to Dr. J. W. Schlegel, who disclosed a series of results which he had obtained by analyses of the scale obtained tray by tray in a multiple pan softener. His original work was done on scale samples taken December 10, 1903, and in his private report[16] which has since been pub-

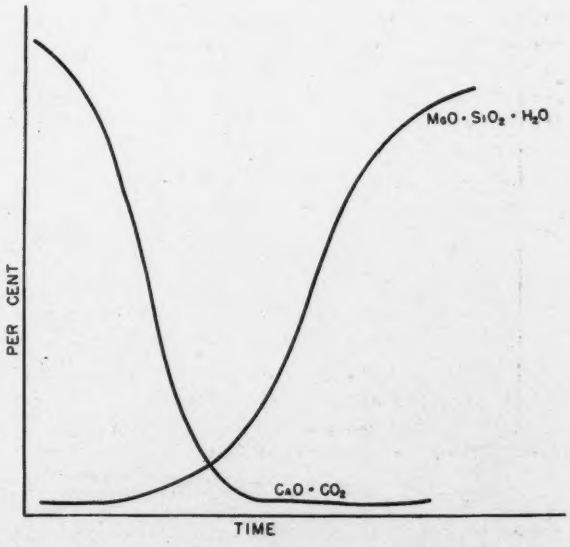


Fig. 1. Relationship of Silica to Magnesium and Calcium to Carbon Dioxide.

*Consulting Engineer, 160 John St., Brooklyn, N. Y.
†Professor of Chemical Engineering, Columbia University, New York City, N. Y.

lished, he stated,—"The marked difference in the composition of these scales appeared so interesting, that a complete set was taken from one purifier. Each scale was carefully collected so as to insure a good average sample, and dried, pulverized and analyzed." Dr. Schlegel had treated the water with caustic soda and soda ash, and allowed it to enter a Hoppes "purifier", in reality a multiple pan feedwater heater. We have plotted his results (Fig. 2) on the same basis as above and find that they also show close correlation of silica and magnesia. The plotted curve shows a little irregularity on the last pans which might be due to some of the calcium carbonate breaking away and landing in the pan below.

At the December meeting of the A. S. M. E. in 1933, in New York, we showed this relationship of the silica and magnesium to Prof. F. G. Straub, of the University of Illinois, who advised us to continue our work. Since that time Professor Straub[17] has published work done on this subject that was begun in April, 1933. His results have substantiated ours. By his use of the bomb he has found that when sodium aluminate, sodium silicate and sodium hydroxide were present in the solution in contact with magnesium oxide, the silica was reduced to less than 0.05 millimole per liter (3ppm SiO_2). The amount of the silica depends upon the relationship of the original silica. The presence of sulphate and chloride along with the aluminate had no retarding effect on the ability of the magnesium oxide to remove the silica from solution. We have pointed out that the combination of

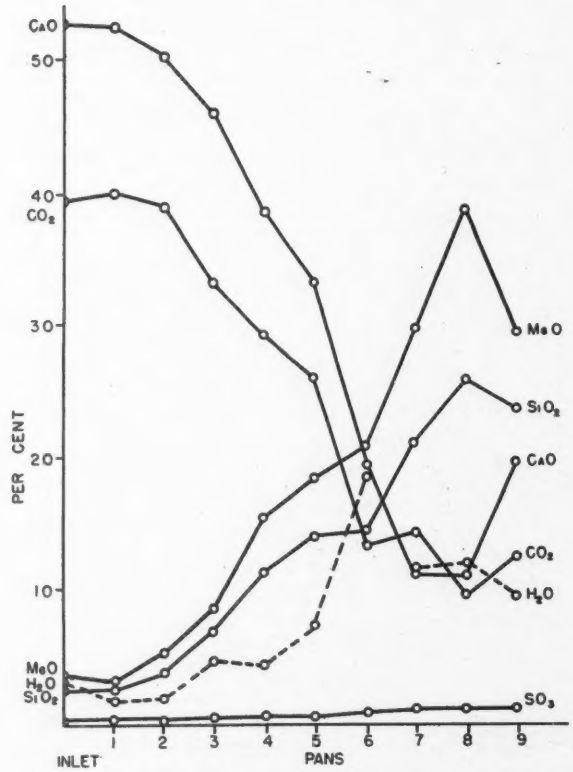


Fig. 2. Dr. Schlegel's curve showing variation in scale analyses from successive pans of feedwater heater

alumina,[15] silica and magnesium forms a flocculent precipitate. If proper amounts of magnesium are used this precipitate will be high in magnesium and low in calcium, with silica less than in calcium silicate scales, the boiler water will show practically zero silica, and the effluent from the softener, will contain less than 2 ppm. silica.

Prof. F. G. Straub also states that magnesium alumino silicate is formed in preference to sodium alumino silicate when the ratio of silica to alumina is less than four, and that when alumina is present more flocculent sludges are formed. In practice we have recommended 3 ppm. of magnesium sulphate for each 1 ppm. of silica, although actually it takes less. In this respect, Professor Straub states that at least a one to one molar magnesium silica ratio is necessary.[18]

Operating Details

Taking the hot process softener as a basis of consideration, the effluent should be maintained at a pH between 8.0 and 9.4. The pH of 9.4[19] is the optimum point, or the point of least solubility of calcium carbonate. Incidently, it is between these points that the least amount of lime is required for the greatest calcium precipitation.

As a rule the amount of lime added to any softener is usually in excess. This excess of lime creates a pH in the water of above 9.4. The magnesium optimum pH point is 10.6[20] at which point the magnesium forms magnesium hydroxide. This point has also been noted as 10.49.[21] The amount of chlorides and sulphates vary this position slightly. Hence, in order to remove all the magnesium, as is done in most softeners, it is necessary to maintain a pH of 10.6. Consequently, more lime is added, and more lime is in solution as calcium hydroxide. But the reaction of the calcium salt, such as calcium hydroxide in water with silica is one in which calcium and silica are precipitated in a compound of variable composition. The composition varies with the amount of silica and the pH. If $CaO,5SiO_2$ is formed, it appears at pH of over 10.1. Thus people have been maintaining a high pH to remove the magnesium, and have allowed the calcium to form silicates at this higher pH which could have been better precipitated by leaving in the magnesium to form silicates at the lower pH or 9.5.[22] The proper method of treatment is to keep the pH of the water at such a point as to remove the maximum calcium and leave the magnesium to remove the silica. As the maximum calcium carbonate and magnesium silicate pH values are very close, it thus makes an ideal method of treatment.

For pressures higher than 300 lb., we have been substituting caustic soda for lime and disodium phosphate for part or all of the soda ash. This we have found very satisfactory as we can remove all the calcium hardness in the water, maintain our proper pH, and have enough magnesium to react properly with the silica. Another advantage is that a definite amount of ortho phosphate excess goes over into the boiler without any phosphate deposition in feedwater lines.

As an adjunctive treatment phosphates are added, although not necessary in most cases. Calcium phos-

phate forms at a pH of 7.0[23] while magnesium phosphate forms at 9.76.[24] From this we see that the magnesium will take out the silica in preference to the phosphate, while the calcium will remove the phosphate. Thus by blocking out the calcium in the softener, we leave magnesium that readily reacts with the weak silicate radical formed in the alkaline solution to produce stable magnesium silicate or magnesium hydrated silicate. As an adjunct, aluminate can be used if not to excess in pressures up to 300 lb.; above that point it is advisable to use ferric iron salts.

As stated before, zeolite softeners do not remove silica. The method to be used in this case, if the water is bicarbonate in nature, is to reduce the pH of the water by adding sulphuric acid to the properly determined pH, thus removing the carbon dioxide. If the water is sulphate in nature, bring the pH in the water up to about 8.0 and add sufficient magnesium sulphate to precipitate out the silica as a sludge in the boiler. If the amount of silica is large, this method may have too large an amount of sludge for the pressure, in which case an organic treatment should be resorted to for which purpose any of the aforesaid materials may be used depending upon the pressure and temperature. In the case of zeolite softeners using unclarified and unchlorinated water, an after coagulant is often advantageous. A selection should be made of one that will remove silica, or produce opposite charges to that set up in the water, and in this way produce finer steam bubbles and make more even steaming. As a rule it has been found that the magnesium salt produces finer steam bubbles and thus makes more even steaming than if not used.

Advantages

Boiler water produced by this method has a lower pH and can be kept under 11.6 at which point silicates are likely to redissolve. Above this point the silica is carried over onto the turbine blades. The character of the water is such that a small amount of carbon dioxide continuously washes the turbine blades and keeps them free of deposits. Turbines so fed with this type of steam have gone over 42 months without cleaning. The controlled hardness removes the silica leaving only a dust-like coating in the boiler that washes off with a hose and probably only settled out during the cooling down of the boiler. Tests on the boiler water show it to contain usually less than 10 ppm. of silica, and the water is fully soft. The water from the softener will have less than 2 ppm. of silica. The formation of silicate scale is avoided, the tendency toward caustic embrittlement is eliminated, and the liability of silica in the carry-over is prevented.

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Temperature Stresses in Boilers

Too rapid heating or cooling of boilers sets up expansion and contraction stresses that commonly cause leaks.

By C. C. CUSTER

THIS is a much more important subject than might be presumed at first glance. The statement has often been made and the truth of it generally accepted that unequal expansion and contraction stresses often impose greater stresses in a boiler than the mere steam pressure carried.

In the discussion of this subject we wish to differentiate between what may be called reasonable and unavoidable wear and tear of a boiler in service and what may be called extraordinary wear and tear which comes about by unusually bad conditions or mis-management on the part of the operator. Different types of boilers fail in different ways; different designs have different inherent weaknesses. It is well for the engineer or boiler operator to "know his boiler". We may say in a general way that the ordinary horizontal return tubular boiler ought, in ordinary service, to have a useful life of 30 yr., during which time it has probably worn out two sets of flues. Consider, however, the common type of v. t. boiler found on portable steam shovels and used there only because it takes up so little room—on account of our inability to keep the lower flue sheet clear of scale and mud we are probably forced to renew the flues as often as every 5 to 7 yr. One of the commonest ways to shorten the life of a boiler is for the engineer or operator to disregard the effect of expansion and contraction stresses. Some types of boilers are more susceptible to this kind of trouble than others. To illustrate this point a number of typical cases taken from a boiler inspector's notebook will be discussed.

Case No. 1. A young man had learned to operate a traction engine type of agricultural boiler. His routine at cleaning time was to pull the fire, then to blow all the water out of the boiler (without waiting for it to cool down), then a little later he would open the wash out plugs and wash it out. Of course this was a poor procedure, but a little later on the aforesaid young man accepted a job running a h. t. boiler in a little factory. The week's work terminated at Saturday noon and he was supposed to clean the boiler Saturday afternoon. In order to expedite matters he would at 1 p. m., after he had pulled the fire, blow all the water out and leave all the drafts open till the boiler had cooled down. The result was

that in a few months he had about half the flues leaking at the back head of a new boiler when the inspector came round and inquired into the cause of the trouble. The setting being almost red-hot when water was blown, had heated the shell and the cold air through the flues had pulled them loose from the flue-sheet.

Too Rapid Firing Up

Case No. 2. While looking over 160 heating boilers in schools in a large city my attention was called by the foreman in charge of boilers to a case that puzzled him. In one school there was a new boiler of the common type of self-contained, horizontal firebox tubular boiler with two flame passes, the flames going back through the bottom half of flues and returning through the top half to the front.

The two extreme right and left flues of the first pass, the ones nearest the shell, had sprung a leak at the bead and though they had been expanded several times the leak was not cured. The foreman wanted to know why the trouble with this boiler when they had many others of the same type that never gave any trouble.

I told him perhaps I could solve the trouble. Calling the janitor who fired the boiler I asked him how long it took him to get steam up on one of his boilers. He said about a half hour when he had plenty of good kindling! In firing up so fast the flue would expand faster than the adjacent shell and thus work loose.

Probably the type of boiler most susceptible to expansion and contraction troubles is the Scotch marine boiler with internal firebox. This type of boiler is deservedly popular for use on ocean-going vessels on account of the fact that it is capable of handling water with a larger percentage of salt in it than any other type of boiler.

Corrugated Firebox Provides Flexibility

On account of its large diameter and the thickness of its shell this boiler has very heavy joints and a multiplicity of stays and braces and on account of poor circulation it is susceptible to damage if heated up too fast. The internal firebox is of the Morrison or corrugated type to enable it to have a certain flexibility to stand expansion. It is possible, however, to get the top of the boiler quite hot while the bottom remains cold unless artificial means are used to promote circulation while the boiler is being steamed up. This is generally accomplished in one of two different ways; either a hydrokineter (a form of injector), with steam from another boiler is used or there is a special connection made from the blowoff line to the boiler-feed pump whereby water is pumped from the cold part (the bottom of boiler) and discharged through the regular feed line at the top of boiler. This is done while the boiler is being fired up and until the boiler water becomes too hot for the pump to handle. In general, it is customary to allow at least 5 hr. to steam up a large Scotch marine boiler, and if the shift engineer does it in less time he is liable to lose his job over it. If fired up too fast it generally results in the lower part of the girth seam springing a leak and maybe also the longitudinal joint at the bottom showing signs of distress. This is caused by the unusual stress set up in these riveted joints having a tendency to loosen the rivets.

Case No. 3 deals with an old Scotch marine boiler that was on a boat sunk in a storm on Lake Huron. After being under water for 20 yr. this boiler was salvaged and being apparently in fair condition was installed in a municipal lighting plant where it gave fair service for 15 yr. They had considerable trouble to keep the girth and longitudinal joints from leaking but I showed them how they could stop the leak by mixing up a paste of equal parts of neat cement and pine tar and treating the joint with a fillet of this which would make an artificial cement or scale to stop the leak but the next time they fired up the boiler too fast they would probably cause it to leak again. By thus taking pains they found they could operate the boiler for a long period without any leak showing.

Case No. 4 was a Wickes vertical water tube boiler. They had recently blowed a fusible plug on account of low water in this boiler but later on about a dozen tubes in the first pass showed loose and leaky, some at the top flue sheet and some at bottom flue sheet. They asked for a special inspection to determine if the boiler had suffered any appreciable damage from low water. The writer was inclined to believe that water a little low in this type of boiler would not do it serious damage as the ascending steam in the vertical tubes would have a cooling effect but we placed the blame for the loosened tubes on the fact that they recently hired a new shift engineer and he had been firing up the cold boiler too rapidly.

In this connection we could mention several boilers, now of practically obsolete design, where the cause of their failure was inability to withstand contraction and expansion strains. In one of these, a water tube boiler, the connection between the headers and the steam drum was too rigid and after a short period of service they would spring a leak at the throat-sheet, which could be mended only temporarily by caulking.

Improper Banking

Case No. 5 was two h.r.t. boilers in a battery, used about 18 hr. per day. About half this time the load required the use of two boilers; after this period passed the load became so light that one boiler was amply sufficient. The engineer, instead of cutting the boiler out, would bank the fire in one and leave it on the line. After a while the boiler would have hot steam in the top and be comparatively cold at the bottom. The inspector told the operator that this was just another way of abusing a boiler and that it would result in a leaky girth seam. Later inspection showed that the girth seam had already begun to leak.

Experience thus goes to show that boilers must be designed to be flexible to withstand contraction and expansion stresses, they must be installed to be capable of free expansion to stand temperature changes and in steaming up or cooling down, these temperature changes must be brought about in a gradual manner.

Turbine Blade Research

Philadelphia Electric Co. and Westinghouse Electric & Manufacturing Co. install specially built high-pressure, high-temperature turbine in Schuylkill Station which will operate under commercial loads but will give opportunity to study behavior of blades made of various metals under operating conditions. Studies are expected to result in fundamental gains for science and engineering.

N. E. Funk, Vice President of the Philadelphia Electric Co. and F. T. Hague of the Westinghouse Electric & Mfg. Co. view ground glass screen apparatus that gives picture of turbine blade vibration under operating conditions

OPPORTUNITY was given engineers in Philadelphia on February 27 to observe the vibration of turbine blades while in service generating power in the Schuylkill Generating Station of the Philadelphia Electric Co. The new specially built turbine was shown for the first time in connection with a meeting of the local section of the American Society of Mechanical Engineers at which F. T. Hague, Engineering Manager, Steam Division of the Westinghouse Electric & Mfg. Co. described features of the research work that is being carried on to solve the problem of turbine blade failure which has been experienced in turbines in the high-pressure, high-temperature range.

This turbine has a built-in viewing device which shows on a ground glass screen a beam of light so reflected as to trace a zigzag pattern, the path being determined by vibrations of specially designed turbine blades. The investigation being carried on jointly by the Philadelphia Electric Co. and the Westinghouse Electric & Mfg. Co. is for the purpose of determining the little-known properties and behaviors of metals when subjected to high pressures and temperatures. The turbine drives a 10,000 kw. generator and takes steam at 1250 lb. pressure, 900 deg. F. temperature. The steam velocity at the nozzles is 1500 mi. per hr. or about twice the velocity of sounds. Turbine blades struck once or more times per revolution of the turbine by the terrific force of this steam jet vibrator like so many tuning forks. In this turbine the rate is in the neighborhood of 126,000 per minute. The significance of this was brought out by Mr. Hague in a lecture and demonstration presented before the society during

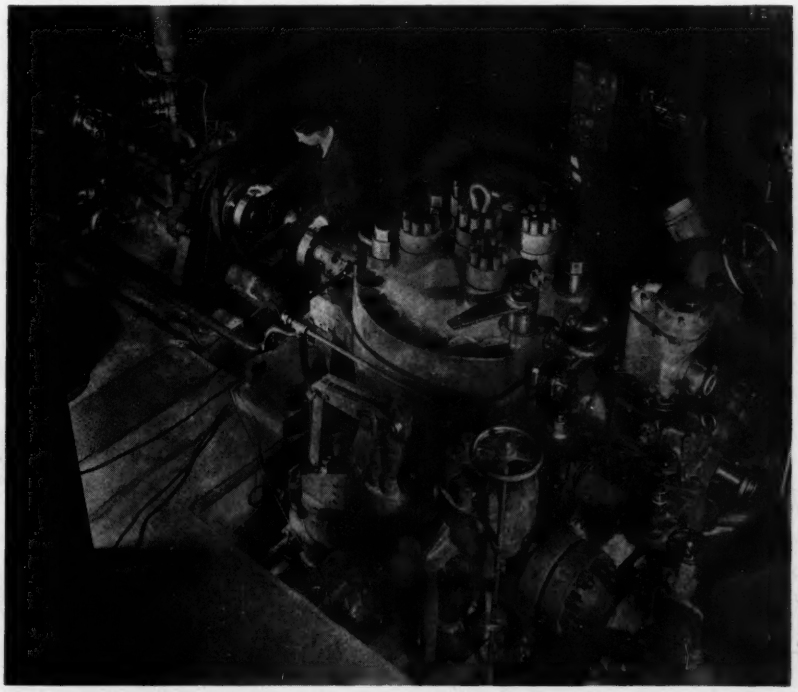


Fig. 1. Experimental turbine with its 15,000-hp. water brake and 10,000-kw. generator which was put into operation in the Schuylkill Station in February, using steam at 1250 lb. pressure and 900 deg. F. equipped with apparatus to indicate and photograph blade vibration under operating conditions

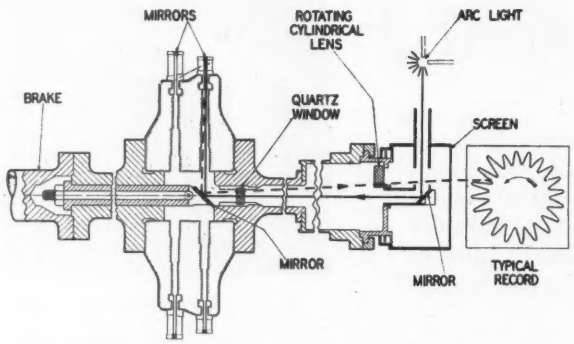


Fig. 2. Diagram of optical system used in impulse turbine blade research

the evening meeting, from which the following paragraphs have been abstracted:

Superposed turbines pass from 1 to 1½ million lb. of steam per hour at a density five times as great as the low-pressure turbines with which they are in series and the steam temperature is 900 deg. The passage of a large volume of dense high temperature steam through the first wheel creates conditions unlike those with which there has been much previous experience. For each 20 deg. increase in temperature in this region, the plastic flow or creep rate of steel is doubled and other physical characteristics are adversely affected.

To obtain good economy at partial loads the incoming steam is fed to this first wheel, at only a portion of its periphery, and the blades passing into and out of this steam jet receive a most violent shock each revolution of the turbine. Shock and vibration of these first row blades is aggravated by this intermittent steam loading. This condition of intermittent steam loading has been conventional for many years on all sizes of condensing turbines. It has been only on those few machines of the large superposed class that its use, in an endeavor to develop the ultimate in partial load efficiency, has caused some blades to break at their root where they are fastened to the spindle. The prompt failure of three successive sets of physically larger blades on a large superposed turbine indicated that something more than brute strength is required of impulse blades in this application when intermittent steam loading is involved.

Nothing short of actually photographing the blades' movements under actual operating conditions promised to give adequate and accurate records of the stresses imposed on these blades. An ingenious optical method of accomplishing this has been devised and the turbine blades are made to write their own story in a camera adjacent to the turbine. Tiny mirrors are mounted inside eight different blades in the first and second blade rows. A light beam projected through a hole in the turbine shaft is reflected by an inclined mirror to the mirror in the whirling blade being photographed and then back out through the shaft to the stationary camera or viewing screen. By taking pictures every one-half second on moving film, an exact record of blade performance is obtained for any desired set of operating conditions.

The first development turbine with this built-in optical system has been in operation in the Westinghouse plant since last September. More than 20,000 photographic records have been obtained showing the performance of impulse blades in a wide range of operating conditions. Single blades and shrouded blade groups have been tested in the first and second rows of a Curtis stage under available plant steam conditions of 400 lb. and 600 deg. Though the pressure and temperature of our plant are not those met in commercial service, nevertheless the photographic method developed will apply with equal success to any commercial steam conditions.

Evidence Obtained

Examination of a typical photographic record of a blade's movements during one complete revolution of spindle shows that the blades vibrate like a tuning fork. The vibration is increased as a blade enters the steam jet, it vibrates while in the jet and continues to vibrate with slowly decreasing amplitude after it leaves the steam jet. This slowly decreasing amplitude of vibration is significant because it is caused by the internal molecular friction of the blade material which will hereafter be referred to as the damping characteristic of the blade steel. The blades vibrate at their natural frequency. This is true whether the steam shock is light or strong and is independent of turbine speed. The natural frequency of vibration is fixed by the blade design and material.

In superposed turbines the frequency of vibration of first row blades is about 2500 cycles per second, one of the highest notes on a piano, or 200,000,000 cycles per 24 hr. day. Blades stressed at their fatigue limit usually break within 10,000,000 cycles. This explains why failures of blades in the first row of superposed turbines usually develop quite promptly, if they fail at all, particularly if the turbine is loaded at half load or below where intermittent steam loading is involved. As the turbine load is increased the steam jet covers more and more of the periphery of the first wheel until above three quarters load we ordinarily have full admission, that is, steam is applied throughout the entire periphery of the first wheel. When the full admis-

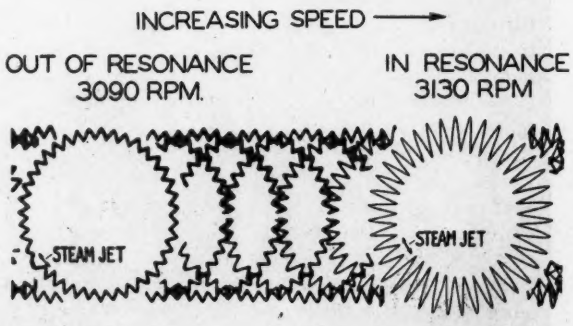


Fig. 3. Records of turbine blade motion showing effect of change of speed on amplitude of vibration

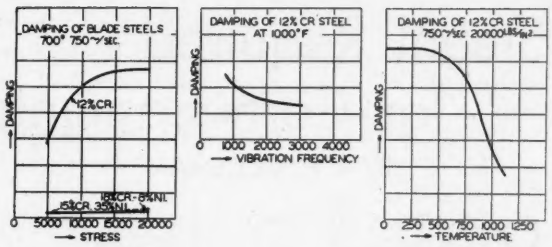


Fig. 4. Damping characteristics of turbine blade steels

sion condition is established, this vibratory stress condition is eliminated.

What the Studies Show

Strange though it may seem, the amount of load on the turbine has relatively little to do with the maximum blade stress. The factors which influence this condition are mechanical resonance and the damping characteristic of the blade steel.

Mechanical resonance involves a relationship of two frequencies, and in turbines one of these is the frequency of the shock from the steam jet. The other is the natural vibrating period of the blade. When these two frequencies are in such a relation that one is the exact integral multiple of the other, resonance results.

Every mechanical system has a natural period of vibration and every one can be set into resonance by being hit on the right frequency. When resonance is produced in any mechanical system, the magnification of stress is limited solely by the damping of the material used. The ability of a turbine blade to operate without breakage depends largely on whether the damping within the blade is sufficient to choke the vibration established during resonant conditions.

Resonance

With any constant turbine load, the magnitude of blade stress has been found to vary over a four to one range as the turbine speed is changed as little as 2 per cent. It is this four to one range or build-up of blade stress at constant turbine load which is the cause of the breakage of blades in superposed turbines. We have an illustration (Fig. 3) taken from an actual turbine in constant load operation wherein the only variable is a slight change in turbine speed; in this particular test turbine it took a change in speed of 1⅓ per cent to go from the resonant condition to the non-resonant condition.

Out of resonance is illustrated on the left part of the cut and in resonance on the right part. This illustration consists of about seven or eight photographic records of blade performance taken one-half second apart as the turbine speed is slowly changed from the 3090 revolution condition to the 3130. This variation of speed is the only difference between these successive records of blade performance. In order to get all of these records on one illustration to show them in sufficient scale we take these records overlapping and for sake of clarity have rubbed out all of the overlapping records on the first and last ones. They represent the "out of resonance" and the "in resonance" blade performance records.

Examine the record on the extreme right and notice that as the blade passes through the steam jet, there is no variation whatsoever in the frequency. In that case we have established the conditions required for resonance. The steam jet is hitting the blade in phase with its existing vibration and, as a result, it builds this vibration amplitude up to a large value, controlled and limited by the damping capacity of the blade steel. It is that condition which increases the blade stress by a factor of four to one, even though the turbine load is constant, and it is that amplification of blade stress which breaks the blades in superposed turbines.

It is obvious, therefore, that the impulse blading of large superposed turbines must be designed to operate at safe stresses under resonant conditions. While actual turbines run at constant speed the natural period of blades will vary more than 10 per cent by virtue of manufacturing variations, changes in operating temperatures, etc., so that some of the blades will be in resonance under all operating conditions.

Dampening

One phase of our investigation has been to explore the factors affecting dampening, and if, under proper conditions, the inherent ability of a blade to protect itself is enough, or if some additional help must be administered. Several important dampening relationships are shown.

1. Dampening is not constant, but increases with blade stress and is extremely low at low stress. It is as important to know this relationship as to know the strength of steel.

2. The dampening characteristics of different steels vary widely. The widely used 12 per cent chrome steel has more damping in its usable application range than any other material yet investigated. The materials of the chrome nickel class that excel in high strength at high temperatures have about one-tenth as much damping as 12 per cent chrome steel.

3. Damping becomes less as the frequency of vibration increases. This means that the increased stiffness of heavier blades does not result in much lower blade stresses.

4. Dampening decreases rapidly at higher operating temperatures, particularly beyond 750 deg. At 1000 deg. the dampening is only one-third as much as at room temperature, and is decreasing precipitously.

Separate Dampers

These findings suggest the possibilities of applying some sort of separate dampers to the blades. We are investigating separate damping means that increase the damping of blades by five to ten times. A steel capsule, partly filled with material that is fluid at operating temperatures can be inserted

inside a blade and maintain its full damping capacity up to 1500 deg. F.

It must not be inferred that superposed turbines for present day standards of temperature and pressure must have separate blade dampers to operate safely. This research merely points out that such means would greatly increase the factor of safety of impulse blades and such means may be required to meet future operating conditions.

Calculation of Blade Stresses

Our research shows that impulse blade stresses can be calculated. The calculation system developed by Mr. Kroon of the Westinghouse Company based on this resonant method of analysis permits a rational evaluation of controllable design features and makes it possible to predict whether a certain design is safe.

Building on the experience with an experimental turbine at South Philadelphia, a second one with full size impulse wheel was built for research study of blade performance under 1250 lb. 900 deg. steam operating conditions. This turbine with its 10,000 kw. generator and 15,000 hp. water brake began testing operation in February in the Schuylkill Plant of the Philadelphia Electric Co. This turbine takes steam from the station 1250 lb. steam lines and exhausts into the low-pressure 240 lb. lines permitting its operation as a superposed unit without interference with the station's regular operation. This turbine is built solely for research purposes and has many special constructional features, including single and double blades, separate blade dampers, different shroud attachments, and various blade groupings. The optical system will record the performance of sixteen different blade combinations. Two rotors are built with different blade design and the presence of the 10,000 kw. generator will permit life tests by loading into the Philadelphia Electric system.

Reference to this unit must acknowledge the joint research relationship with the Philadelphia Electric Co. They are making available the use of their station, operators, and steam supply. This contribution to research on a central station industry problem is a tribute to the broad viewpoint of their management.

Today we are making a progress report on our research studies. To maintain proper perspective it should be remembered that the impulse blade problem has been critical on only a few large superposed turbines, which although an important factor in the industry, are nevertheless a small portion of the turbine business. We have an excellent tool for diagnosing the duty and stress of impulse blades. From the research studies of this installation will come a visual record of impulse blade operation which will expedite the engineering solution of the impulse blade problem. It has been our experience that research problems are more readily solved when measuring instruments are evolved which make possible quantitative measurements of occurring phenomena. We have that instrument in this photographic method.

Steam Required for Corn Canning

BY S. H. COLEMAN

OPERATING STATISTICS concerning the steam consumption of a given process are always interesting to engineers who are responsible for the operation or design of similar plants employing substantially the same manufacturing procedure. This is especially true of those processes operating on a seasonal basis where because of the necessity of limiting investment in plant machines and structures, equipment refinements such as metering devices are very rarely installed and accurate figures relating to the steam generating capacity required are very hard to obtain. Typical of these establishments are the many corn canneries scattered throughout the country with their greatest productive capacity centered in the middle west and upper lake regions.

With this thought in mind, the following figures giving the details of steam production on a typical day in a large corn cannery provided with boiler flowmeters are presented for what they are worth.

No. of cases (24 No. 2 cans each) cream style corn processed, 24 hr. period	17,096
No. of No. 2 cans processed	410,304
Lb. coal (Western Kentucky) required	28,915
Heat content of coal as fired, B.t.u.	12,320
Lb. coal required per case of product	1.69
Lb. coal required per No. 2 can of product	.07
Active boiler hours	20
Banked boiler hours	4
Lb. steam generated at 140 lb. ga. sat	248,000
Average feedwater temperature deg. F.	216
Factor of evaporation	10.04
Water evaporated F & A 212 deg. F. per lb. fuel	8.9
Boiler efficiency %, average over 24 hours	70.1

Plant Productive Capacity

Maximum daily capacity, cases (24 No. 2 cans)	20,000
No. of filling and closing lines	7
Cooking retorts (4 crate vertical)	42
Cooking cycle, minutes	70
Operating season, days	30–35

Steam load carried on one 3000 sq. ft. low headroom, 2 drum, bent tube, inclined type water tube boiler fired with a single retort side dump underfeed stoker.

By the use of Cone worms of nickel-chromium-molybdenum, steel with nickel bronze worm wheels, Timken nickel alloy steel roller bearings and nickel cast iron housings, Michigan Tool Co. has reduced the size of heavy duty speed reducers by ⅓, giving lighter weight and greater flexibility in application.

Business and the Public

ANY SUCCESSFUL business must render a desired service to the public by furnishing usable goods or conveniences; either a manufacturing procedure or personal service. If a business fails to fulfill one of these functions, it will not prosper and will have but a short life. Acceptance of the product by the Public is, therefore, essential to business existence.

What, then, are the factors that make for public acceptance? A. G. Keller, in his treatise on Brass Tacks, gives three factors as the motivation for human action. (A) Self preservation, including food, clothing, shelter and security. (B) Love, family and sex relations. (C) Gratification of desires, and vanity. To gain public acceptance, products should have appeal to one or more of these factors. Society has become organized to meet these motivation factors, by combining into groups for economic production and defense; by establishing laws and government; by providing means for distribution and exchange of products.

In a free industrial and governmental system, organization has been perfected by trial, error and selection to meet conditions, and the existing organization is a survival of what has proved most fitting. While it may have defects, its advantages have proved sufficient to secure its retention. In a dictatorship or a bureaucratic government, organization is enforced according to the ideas of one or a few men and the tendency is to perpetuate errors and bad practices for the benefit of those in power.

Organization to deal with factor (A) comprises industrial, economic and religious bodies, to ensure employment, fair distribution of the proceeds of labor, and square dealing among individuals and groups. To deal with factor (B) the clan, kinship and the family are developed. Factor (C) is as capable of unlimited development as the range of human desires. Man has risen from the poverty of primitive peoples by work and thrift; stored capital providing food, clothing, shelter, and tools for increasing the results of work, as a fortification against want and bad luck. This has given a margin above necessities to provide comforts and luxuries, and want of new comforts and luxuries has always increased faster than supply. Wants supplied breed more wants, so that there is ever increasing need for work and thrift to provide more capital by which increased wants can be supplied. Work and thrift are the means by which man has risen from caves and huts to civilization as we know it. The same practices are necessary to avoid return to privation and to increase wealth and well being.

Spite of all altruistic ideals, accumulation of capital, which society needs to progress, requires the right of private possession and ownership and a reward to those whose industry and thrift provide the capital. It is unreasonable to expect some to work and practice self denial of immediate satisfactions in order to provide benefits for others, unless they are compensated for use of the capital they have created.

With the provision of capital and establishment and improvement of industry, arises the need of safeguarding the continuation of industrial organization to ensure employment. This involves securing public acceptance of product and creation of sufficient backlog to tide over periods of slack business and to develop new or improve present products as conditions change. It is only by public acceptance and consent that a business can exist and grow. There are no "natural rights" for either organizations or individuals. Even the "right to life" depends on observance of the laws of health and hygiene to avoid contracting disease. Rights are acquired by earning them.

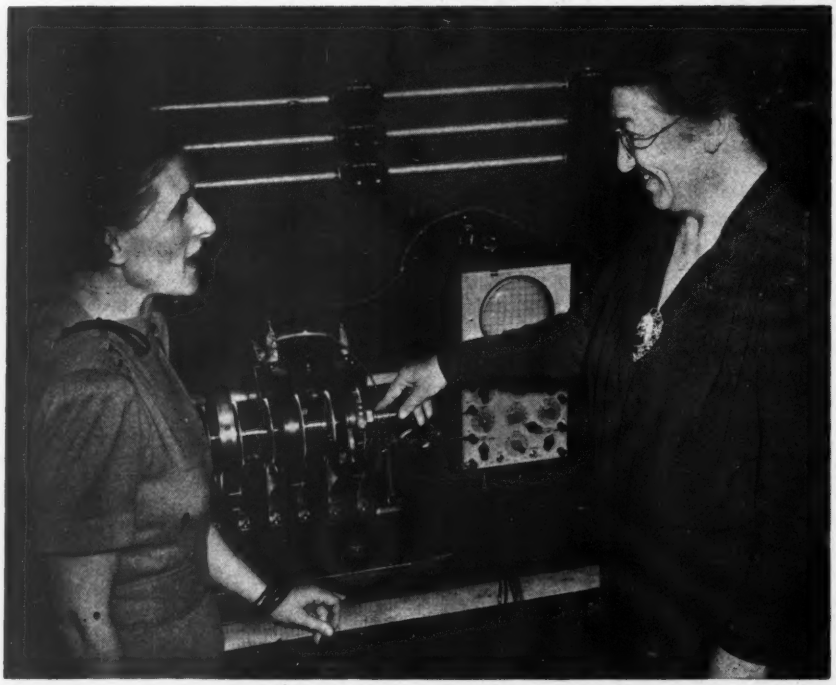
Business is not concerned with religions, except so far as establishment of moral and ethical codes forms the basis for square dealing inside the organization and with the public. And it should be recognized that the square deal policy applies to the treatment of capitalists and managers as well as to workers and the public. A capitalist is anybody who has loaned or invested money, whether by depositing in a savings bank, buying life insurance, bonds or stock, regardless of how small the amount involved. The man who invests in a productive business is as much entitled to payment for the use of capital as is the man who deposits in a savings bank or buys life insurance.

Regulation to ensure that the investor and the public are fairly treated is a legitimate governmental function. But such regulation should not be of a nature to prevent free manufacture of and trading in manufactured products and services of good quality at fair prices.

These two are the chief factors in public acceptance of any products. Good quality and fair price. Unless quality is good, of either products or services, the public will not long buy. Unless the public considers prices fair, it will not buy at all. Here lies the problem of the industrial manager. He is no different from other workers in a business organization except that he has the responsibility of planning and guiding the work of others and the policy of the organization. To succeed, he must gain the confidence of fellow workers and have their cooperation; also must gain the confidence of the public in the quality of the organization's product and in the certainty of a square deal in prices and treatment.

Satisfactory working conditions and reasonable compensation are the basis of loyalty and cooperation in the organization. Careful production and inspection methods and keeping costs such that the public is willing to pay the prices necessary to produce a profit are the basis of public acceptance. These two requisites for success involve multitudes of details which call for careful consideration. But the fundamentals of public acceptance are confidence in the company, reliable products with the quality as represented and expected, and a fair price for that quality.

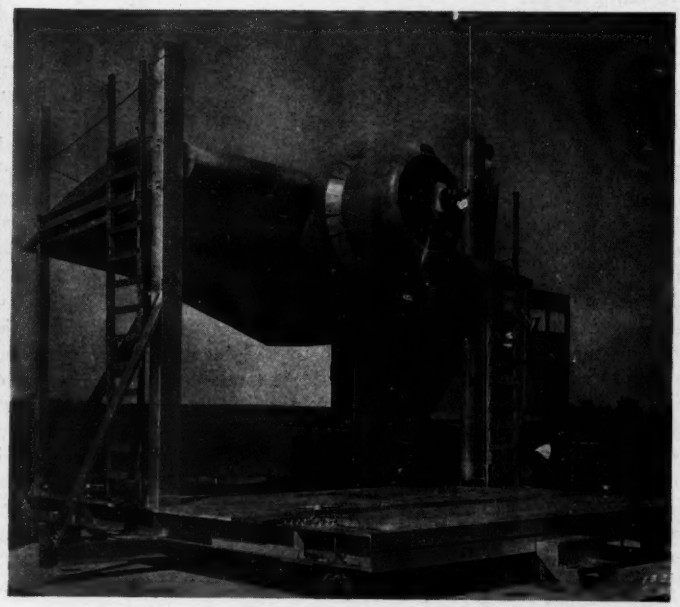
PICTURES of Engineering



"Now, of course, by the method of symmetrical components . . . . . " Power transmission is a subject few women in the world could use for conversational material but when these two ladies met for the first time at Schenectady recently it was a lively topic for discussion. Miss Vivien Kellems (left) head of a company which manufactures cable grips and Miss Edith Clarke, General Electric engineer specializing in power transmission problems are two of the only three women with full membership in the American Institute of Electrical Engineers. The third, Mrs. Mabel Rockwell, is associated with the Lockheed Aircraft Corporation. Miss Clarke has presented many papers on transmission studies before the A. I. E. E.

Design for Rats. Short circuiting of lines by rats coming in contact with these circuit breaker terminals led the engineers of the U. S. Rubber Co. to devise the rubber boots shown here.

Testing Flying Power. When a man makes his first visit to an aircraft factory it is natural for him to ask "But, after you have finished designing a new model how do you know it will fly?" It is a fair question and one answer to it is this engine test rig which Glen L. Martin Co. engineers have built to test the performance of engines before they ever leave the earth. It consists of a turntable, a mock portion of an airplane, and an observer's balcony with instruments for analyzing and recording temperature and pressure conditions. Separately mounted on the ground nearby is complete equipment for vibration study.

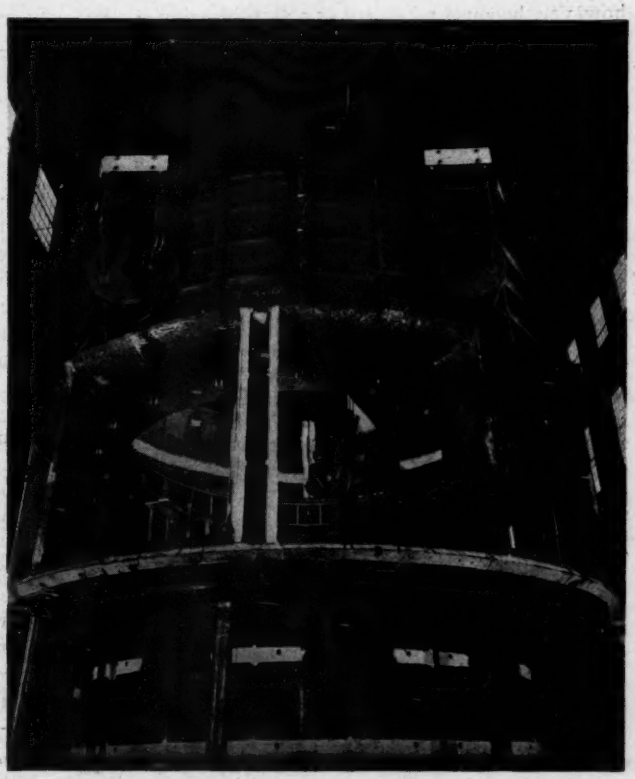


Interest

Extraordinary daylight working conditions characterize this machine shop where injectors for the Cummins Engine Company's diesel units are produced. Shadow producing members normally encountered in shops of this type have been completely eliminated by rigid frame construction employing welded "tree-form" columns designed by Austin Company engineers to support the saw tooth roof without any necessity for bracing. Modern equipment includes unit heaters, combination mercury vapor and Mazda lighting units and overhead buses for electrical distribution.

No, it's not a new type file cabinet! It's a new drawout relay recently developed by General Electric. Miss Jane Mervine of the Philadelphia General Electric Works is discovering that the relay is just as easy to get at as a file in a modern cabinet. It can be withdrawn for inspection without the use of tools and there are no wires to be disconnected.

(Below) A power giant for Santee Cooper Dam. Shop assembly at Allis-Chalmers Mfg. Co. plant in Milwaukee of one of the two 40,000 hp. 70 ft. head concrete spiral casing type of hydraulic turbines now under construction for the South Carolina Public Service Authority, Santee-Cooper Hydro-electric Project near Charleston. The stationary parts, assembled as shown and all made of steel, consisting of discharge ring, guide vane ring, speed ring, outer cover plate and pit line, weigh approximately 350,000 lb. The overall height shown is 22 ft., the speed ring having an outside diameter of 26½ ft.



THE AMPLIDYNE

THE USE OF AMPLIFIERS has become common knowledge in radio and the communication field but the term has not been applied to any extent to processes in power engineering. Strictly speaking, a radio amplifier is only a form of control because we always tap a new source of power and the function of the amplifier is to control this power so as to reproduce the changes of energy flow at a higher power level. From this standpoint an ordinary d.c. generator is an amplifier because we control the power output by the current in the field winding.

Terminology of this kind would be misleading, however, because when we say amplification we imply something more specific than when we say control. An amplifier should give accurate reproduction both of intensity and time intervals, whereas controlled power circuits used so far have not met these requirements. In the radio frequency amplifier we are dealing with a time element of less than a millionth of a second and in an audio frequency amplifier the time element is about one five thousandths of a second. The only device we know of that will respond in such a short time is the high vacuum electron tube.

When it became apparent that amplifiers were needed in engineering it was natural to turn to the vacuum tube. The high vacuum tube, because of its power limitations, did not lend itself well to heavy power circuits; for this purpose the mercury vapor, or thyratron tube, was found more successful. The thyratron amplifier has an extremely high ratio of amplification and it has found many successful applications in industrial work.

A thyratron amplifier, for example, may be controlled from a small regulator and may be used to furnish excitation of large synchronous machines. Installations of this type have proved very successful and are superior to the conventional type of exciter in providing quick response to sudden changes in load. From an engineering standpoint this type of installation is highly successful but, unfortunately, in the present stage of its development, the costs are such that it is not justified economically.

It was this success in the application of thyratron amplifiers that led E. F. W. Alexanderson and a group of his associates at the General Electric Co. to consider what other means might be available to provide an amplifier for power purposes[1]. The type of dynamo-electric amplifier which was developed as a result of these considerations meets the requirements demanded of it to a high degree and provides a new and useful control device for industrial applications of all types.

In the development of this device the theory of radio amplification served as a guide. It was found

In considering the development of electron tube applications a noted engineer speaking before a group of engineers recently, divided the history of tube development into various phases. The first stage from, say, 1905 to 1920 was the beginning stage. This was followed by a period which he called the ridicule stage because engineers did not have much faith in such a fragile device. Then came the glamour stage—the period when the electron tube was going to revolutionize the world and all sorts of applications were made of it. This was naturally followed by "the morning after" stage, when people began to realize that the vacuum was not a panacea for everything and that some things could be done better without tubes.

The Amplidyne generator represents a case in the latter category. It is an amplifier but it amplifies without the use of vacuum tubes. It was described in a series of three papers before the recent A.I.E.E. convention in New York by engineers of the General Electric Co. and the article presented here, is an abstract of the material contained in these papers. Anybody interested in the application of electricity in power and industry should find this device intriguing.

[1] Dynamoelectric Amplifier for Power Control. E. F. W. Alexanderson, M. A. Edwards, and K. K. Bowman.

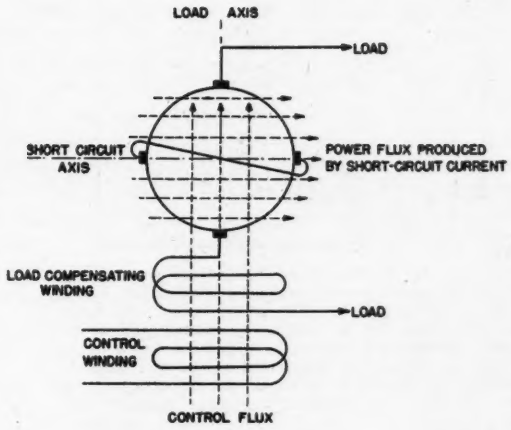


Fig. 1

in the design of radio amplifiers that the ratio of amplification or the sensitivity can be increased within certain limits by sacrificing the quickness of response. Thus an improvement of 10 to 1 in sensitivity might be gained by permitting the process to take ten times as long. The same general principle applies to the dynamo electric amplifier. In radio it was found that by using amplification in several stages sensitivity is gained in geometric progression without sacrifice of speed of response.

The dynamoelectric amplifier which has been named the Amplidyne generator also operates on this principle. It is a two-stage amplifier incorporated in a single dynamoelectric machine. In its physical structure it resembles a direct current motor but is different, of course, in its electrical structure. A diagram showing the principles of its design is shown in Fig. 1. As will be noted, it is characterized principally by a pair of short circuited brushes at right angles to the power brushes. The first stage of amplification is from the control field to the short circuited brushes and the second stage from the short circuited brushes to the power brushes.

The principal elements are: 1. The control field. 2. The short circuit axis on the armature; and 3. An output circuit from the armature including a compensating winding.

The Amplidyne generator has a rotating member which is driven at constant speed by a motor or other prime mover. A comparatively small current (obtained from an external source) applied to the control winding (which may be thought of as a *field* winding) results in a current of considerable magnitude between the short circuited brushes. This short circuit current produces a power flux at right angles to the control flux and this power flux results in a still larger current in the load winding or output circuit.

The output circuit, it will be noted, has in series with it another winding called the compensating winding. The purpose of this compensating winding is to neutralize any back coupling that might exist between the output circuit and the control winding. The output circuit, as shown, is on the same magnetic axis as the control circuit, hence there may be a direct magnetic back coupling from the output circuit to the control circuit. This would result in regeneration and oscillations similar to those encountered in radio amplifiers. The compensating winding is designed to prevent such back coupling.

A high ratio of amplification, of the order of 10,000 to 1, can be realized with the Amplidyne system. That is, an impulse delivered to the control winding is reproduced with 10,000 times greater power at the output terminals. An amplication of about 1 to 100 is obtained between the input winding (control winding) and the short circuit axis and another amplification of 1 to 100 takes place between the short circuit axis and the output axis. The overall amplification of 1 to 10,000, of course, is the product of the amplification in the two stages.

The system operates on both direct and alternating current, that is the input may be either direct or alternating current. No attempt will be made here to discuss the theory of the device nor its adjustment for different conditions of operation, as these are both complex; we will, however, consider a few of the ways in which the Amplidyne has been applied in industry. These applications were described in a paper before the American Institute of Electrical Engineers' Convention in New York last January[2].

As pointed out in this paper, there are three more or less basic ways in which the Amplidyne generators may be employed in closed cycle controllers.

In the first and simplest method as illustrated in Fig. 2 the Amplidyne exciter is equipped with two balanced fields on the control axis. One of these fields is excited from a source which provides the primary standard of performance. The excitation power supplied from this cource is many times

[2]Industrial Applications of Amplidyne Generators. By D. R. Shoults, M. A. Edwards and F. E. Crever.

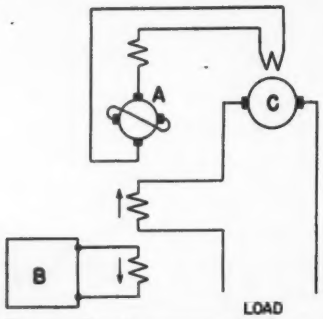


Fig. 2. Circuit arrangement of an amplidyne exciter, used in a closed control system, excited by balanced field action. A. Amplidyne exciter with compensating field and approved control fields. B. Any suitable primary current source. C. Separately excited d.c. generator, controlled to deliver current proportional to that of the primary source

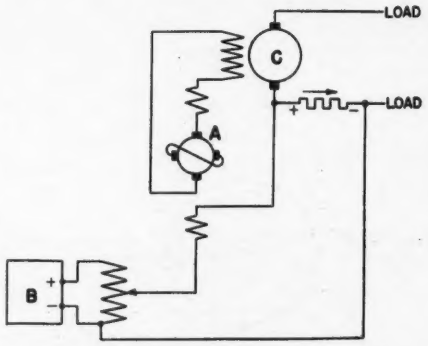


Fig. 3. Circuit arrangement of an amplidyne exciter, used in a closed control system, excited from a differential voltage source. A. Amplidyne exciter with compensating and control fields. B. Any suitable primary source of d.c. voltage. C. Separately excited d.c. generator controlled to deliver current proportional to the voltage of the primary source

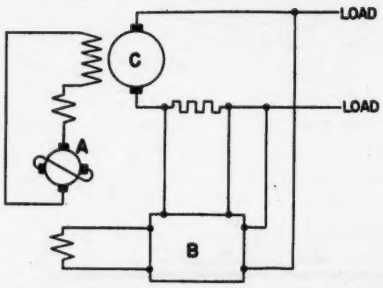


Fig. 4. Circuit arrangement of an amplidyne exciter used in a closed control system, excited by a composing amplifier. A. Amplidyne exciter with compensating and control fields. B. Composing amplifier combining current, and voltage of d.c. generator in required relationship with suitable standards to provide the amplidyne excitation. C. Separately excited d.c. generator controlled to operate with a specified current voltage relationship

that required to obtain full output from the Amplidyne generator. The second field is excited from the output function of the apparatus, which, in Fig. 2, is the line current of a d.c. generator but may be alternately speed, voltage, position or other characteristic such that the control field current will be proportional to this final function. This excitation, differential with respect to the primary excitation, is also many times that required to excite the Amplidyne amplifier. The net difference of these two exciting components then produces such excitation as may be required for the control range required.

The second method of obtaining the Amplidyne generator excitation is from differential voltage circuits as illustrated in Fig. 3. Here the standard of comparison and the indication of output performance are expressed as opposed voltages with their circuits interconnected through the field circuit of the Amplidyne generator. Any deviation of output from the ideal results in a difference in voltage; with a current flow of equivalent direction and magnitude through the Amplidyne generator field so as to produce a change in output to reduce the deviation. Where sufficient control power is available so that the sources of control voltage are influenced only to a minor degree by the Amplidyne field current, this is an effective means of control. Its accuracy is limited by the power available from the two voltage sources only and in some cases may be made extremely high. The disadvantage of this circuit arrangement is that it requires an electrical interconnection between the two sources of comparison. This may at times be impractical.

A third method of application of the Amplidyne equipment is through the use of supplementary composing amplifiers as illustrated in Fig. 4. The composing amplifier output is used to excite the Amplidyne generator and is arranged in accordance with a desired relation of control functions. With such an amplifier it is possible, for example, to control the voltage of a generator accurately within certain load limits and at these load limits to transfer from voltage to current limit control or vice versa, depending upon operating conditions.

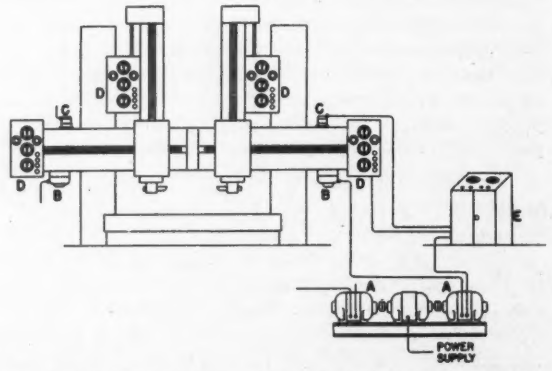


Fig. 5. Schematic arrangement of amplidyne control equipment for automatic positioning of cutting heads on a boring mill. A. Amplidyne generator. B. Control motors. C. Pilot generators. D. Dial indicators and limit switches. E. Main control cabinet

Machine Tool Control

A simple, yet interesting, application of the Amplidyne system is in connection with a multiple head boring mill in the Schenectady Works of the General Electric Co. The two motions on each head of the mill (Fig. 5) are controlled by suitable motor operated lead screws. The control motor for each head is arranged with a double throw mechanical clutch mechanism so that it may operate either lead screw.

The operator may present the next cut to be made by means of dials registering feet, inches and thousandths of inches. When one cut is finished it is only necessary to clutch in the motor to the proper motion, press a button, and the equipment will automatically move the cutting tool to the exact position for the next cut.

This positioning control is obtained by a series of limit switches and accurate mechanical means of operating these from the motion of the heads. Each d.c. control motor is separately excited and receives its armature power from an Amplidyne generator.

The field excitation of the Amplidyne generator is applied through circuits controlled by the precision limit switches. The Amplidyne equipment by virtue of its low control power requirement permits these switches to be small in size and hence accurate in performance. One other important point is that the speed of the control motor is definitely held at any set value by means of the Amplidyne equipment which is excited from a voltage matching circuit. This circuit consists of a pilot generator, driven from the control motor, and a potentiometer circuit across the excitation sources. When the slowdown limit switch is reached the motor is slowed down to 1/50 rated speed by a change in potentiometer connection. This slow speed is held accurately regardless of the friction conditions which are encountered, thus permitting of accurate positioning on the final limit switch.

Synchronous Motor Excitation Control

In a recent installation of a 5000 hp. synchronous motor drive in a steel mill the motor excitation was supplied by an Amplidyne exciter. This was controlled in such a manner that the motor operated with substantially constant leading reactive kv-a. at all loads up to 15 per cent of normal. This control assists the synchronous motor to develop high pullout torque when peak loads are encountered. The 50-kw. Amplidyne exciter control excitation was obtained as a function of motor current and line voltage. As this excitation requirement was of the order of a few watts it was obtained from potential and current transformer circuits without further amplification.

Photoelectric Side Register Control

A number of Amplidyne generators have been built to deliver power to motors holding the registration of a web of paper being rewound and slit as illustrated in Fig. 6. A photoelectric scanning head and amplifier obtains an indication from the edge of the web or from a line printed on the web of paper to determine when the web deviates from its proper position. The indication is amplified by an ordinary vacuum tube amplifier and applied to the control field of the Amplidyne generator. This generator applies power to a separate excited direct current motor which is arranged to shift the main roll of paper sideways to bring about a correction in registration. Arrangements are made so that the paper is moved beneath the scanning point simultaneously with the moving of the main paper roll in order to eliminate any tendency to hunt which would be caused by a lag in the movement of the paper in front of the scanning head after the main paper roll has been moved.

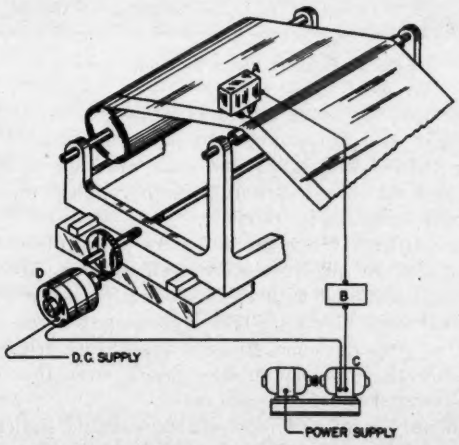


Fig. 6. Photoelectric register equipment using amplidyne generator for power supply to servo-correcting motor. A. Scanning head. B. Electronic amplifier. C. Amplidyne generator. D. Control motor.

An accuracy of approximately 0.01 in. is required in controlling the edge of the paper or line on the paper. When winding at high speed the paper may be found to deviate rapidly from a set position so that a correcting speed of from 30 to 60 in. per min. is required to keep up with the errors introduced in the paper. Thus at times the control line may move the full width of the accuracy zone in only one one-hundredth of a second.

Conclusion

These few applications will serve to show the possibilities inherent in the Amplidyne principle. In the short time since their development these generators have been successfully applied in a considerable number of industrial processes. They are controlling the load division between large parallel operating d. c. motors. In steel mills they are controlling the speed regulation of tandem cold strip mills. In power plants in addition to their use as a means for obtaining close excitation control it would seem that they have possible application in combustion control systems. In short, the Amplidyne generator offers promise in all applications where the use of dynamo-electric machines is desirable but where other types of power amplifiers have been required to obtain proper responsiveness of control.

In a New Lynn, Mass., high school, an auxiliary lighting system recently installed passed its initial tests by coming from "start" to "full load" in less than two seconds. The equipment, supplied by the New England Trawler Equipment Co., consists of a General Electric 7½-kw., 115-v. d.c. generator driven by a Hercules gasoline engine.

In testing the set it was found that the lag was 4 sec. on the first start. As the engine gas line had been completely drained for shipment it was felt that part of the time required to start the set was consumed in filling the carburetor bowl. On the next trial the set was stopped witthin a short time after it had been started and then restarted. On this trial and all subsequent tests the time elapse, from the failure of the normal power until the emergency circuit was carrying full load, was less than 2 sec.

Another feature of this installation is the isolation of vibration. To minimize the vibration, the generator set was mounted in a shallow concrete pit lined with cork. The exhause from the engine was run through a Maxim silencer.

Meeting Increased Steam Needs In Distillery Plant

BY HAROLD G. BURRILL
Consulting Engineer, Baltimore, Md.

FEW INDUSTRIES in this country have undergone greater expansion during the last decade than the one devoted to the distillation of those spirits which contribute so much to the zest and warmth of our cocktail parties—those which W. C. Fields categorically classifies as medicinal spirits.

Among the organizations devoted to the production of high grade liquors, one which has long occupied a position of prominence is the Hunter-Baltimore Rye Distillery and like many others its business has grown in keeping with the increased demand for its products. One of the important elements of a distillery is warehouse capacity for it is in the warehouses of these plants that the liquors are aged and in which they attain the qualities which make them desirable. Such warehouses in order to insure proper aging must be maintained at an even temperature and in winter require considerable steam for heating.

When the Hunter-Baltimore Rye Distillery found it necessary to extend its warehouse facilities at its Gwynnbrook, Maryland, distillery, it was necessary also to add to the existing boiler capacity.

At the time this need arose, the boiler plant consisted of three 150 hp. H.r.t. boilers, hand fired and operating at 125 lb. steam pressure. Since this was an old plant, not susceptible to modernization, a new boiler plant was proposed and after careful study of the requirements, it was found that two 400-hp. boilers would take care of the present load and at the same time give reasonable assurance of the new plant being able to meet future requirements.

Since the existing boiler room was inadequate to house boilers of this size, a new boiler house was also decided upon. This, as shown in the accompanying photograph, is a brick and steel structure, two stories in height and surmounted by a steel stack. It is amply lighted with large steel sash windows on three sides and while not elaborate is thoroughly modern and well suited to its purpose.

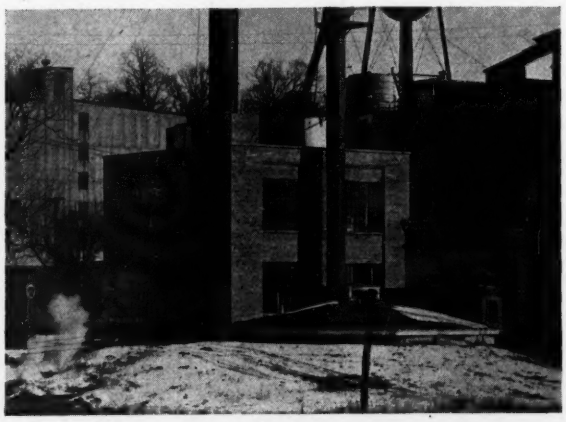


Fig. 2. Exterior view of the boiler house

Two 407-hp. Edge Moor boilers, built for operation at 200 lb. pressure were secured from another plant and installed with Edge Moor superheaters and Diamond soot blowers. The superheaters were provided to provide some 40 deg. superheat, necessary to insure the delivery of dry steam, over the wide areas covered by the warehouses.

An anlysis of the local coals available indicated that pulverized fuel firing would be desirable. The probable load could be expected to vary over a wide

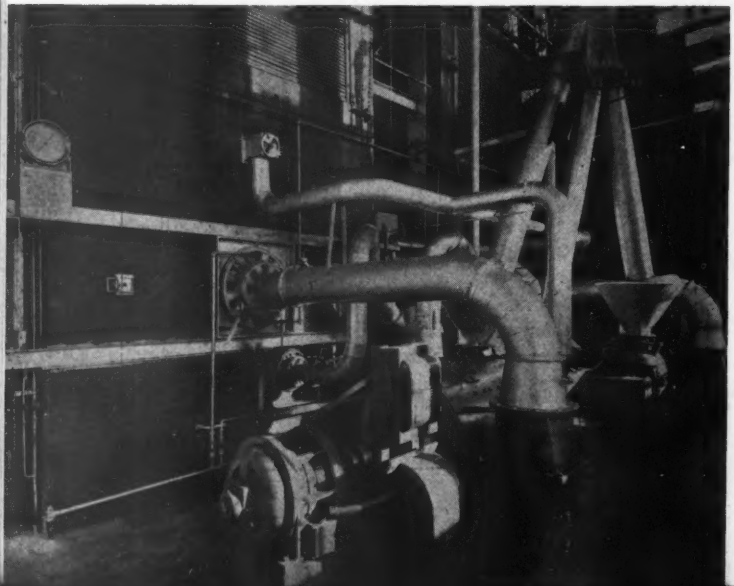


Fig. 1. A view of the new pulverizers

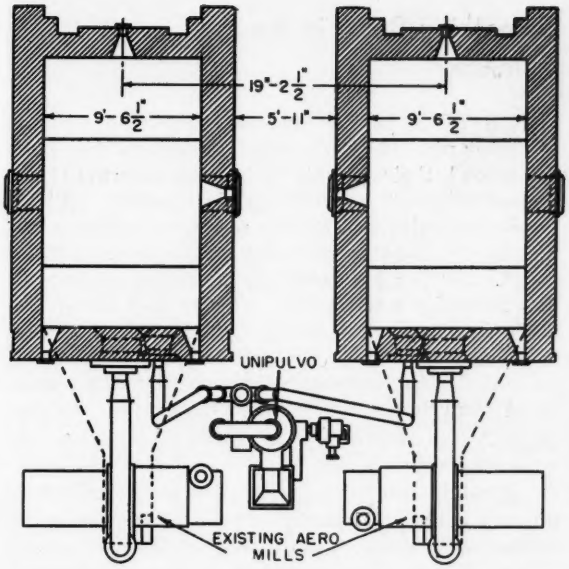
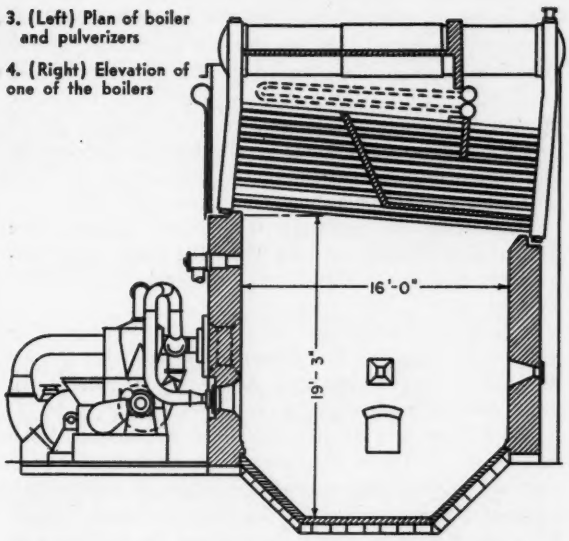


Fig. 3. (Left) Plan of boiler and pulverizers

Fig. 4. (Right) Elevation of one of the boilers



range—as much as twenty to one—and the use of pulverized fuel would meet these conditions.

Two Aero pulverizers having a capacity of from 500 to 3000 lb. of coal per hour were available at another plant and were installed as the main units for each boiler. For use in case either of the main pulverizers failed, and also for use at low loads, or to assist at high loads, another small pulverizer was purchased and installed between the two main units so that it can serve both boilers. The arrangement is shown in the accompanying plan (Fig. 3). This unit, a Unipulvo with a capacity of from 100 to 1000 lb. of coal per hr., was purchased from the Strong-Scott Mfg. Co. of Minneapolis, together with all piping and burners.

As shown on the drawings, two burners per boiler were installed. A large Strong-Scott burner was set centrally in the front wall of each furnace. Another small burner was set nearer the side wall and below the center line of the large burner in order to maintain ignition at low loads and assist in lighting off the large burner.

Lighting off was made easy by installing a small oil burner on each boiler connected to a 275 gal. gravity tank and a pressure blower. Tests made on the installation indicated that the setting was correct and the small burner can be operated at very low ratings.

The boiler loads permitted brick set furnaces which were installed by George Dashiells & Sons of Baltimore, Md. The ash pit was thoroughly insulated and air cooled; the air being drawn through the hollow tile lined ash pit by fans on the pulverizers.

As may be seen from the photographs the entire arrangement is simple and compact and all equipment is readily accessible.

Coal Handling

Coal handling equipment consists of a Jeffrey bucket elevator conveyor, taking the coal from a track hopper and discharging into a 110 t. circular bunker set centrally with respect to the two boilers.

The building steel was laid out so that main columns support the boilers, roof and coal bunker, making a roomy and economically designed boiler house. The coal bunker is of entirely welded construction using U. S. Steel Company's semi-stainless steel called Corten, which reduced the structural weight about 25 per cent.

The water supply for this plant is very pure, analyzing as follows:

pH Value		6.9
Figures in Grains Per Gallon:		
Total Solids		4.08
Volatile Matter		0.21
Hypothetical Combinations of Solids:		
Silica	($S10_2$)	0.38
Iron Oxide & Alumina	(Fe_2O_3; $A1_2O_3$)	0.02
Calcium Carbonate	($CaCO_3$)	1.93
Magnesium Carbonate	($MgCO_3$)	0.04
Magnesium Chloride	($MgCl_2$)	0.27
Magnesium Sulphate	($MgSO_4$)	0.68
Sodium Nitrate	($NaNO_3$)	0.31
Sodium Sulphate	(Na_2SO_4)	0.22
Sulphate to Carbonate Ratio		0.48 to 1

Fig. 5. The boiler room has an abundance of daylight

Because of the high degree of purity it was felt necessary to protect the boilers against dissolved oxygen. An Elliott Co. deaerating feedwater heater and storage tank was installed, the storage tank having a 12 min. supply under normal load. The feedwater heater discharges into a common header connected to two Frederick Iron & Steel Co. feed pumps, one motor driven and the other driven by a Terry steam turbine, so that a uniform plant heat balance could be had.

The small Strong-Scott pulverizer is driven by a 15 hp. Terry steam turbine while the large Aero pulverizers are driven by 50 hp. General Electric Co. motors.

Control of pulverizer is effected by means of a Brooke Engineering Co. pressure control with Brown CO_2 meters and steam flow meters all mounted on a large central control panel.

The plant was started up, tested and operated for some time on Davis Coal and Coke Co.'s coal, and a CO_2 of 14 per cent was easily obtained under both light and heavy loads. The furnaces being all refractory, ignition was easily maintained on low as well as high volatile coals, both of which have since been tried with good results.

Boilers are operated alternately about one month at a time when burning low ash coal and then taken off and cleaned, no ash or slag is removed during this period.

Illustrations show various views of both building and equipment.

The entire job was handled by the Consulting Engineer, assisted by Mr. William E. Lahm, Superintendent, and Mr. H. E. Hough, Distiller, at the plant.

List of Principal Equipment

Boilers and Superheaters	Edge Moor Iron Works, Inc.
Feed Water Regulators	Copes, Northern Equipment Co.
Feed Water Pumps	Frederick Iron and Steel Co.
Soot Blowers	Diamond Power Specialty Corp.
Pulverizers & Burners	Aero, Foster Wheeler and Strong-Scott
Auxiliary Turbines	Terry Steam Turbine Co.
Motors	General Electric Co.
Control	Brooke Engineering Co.
Meters	Brown Instrument Co.
Fire Brick	Harbison Walker and General Refractories
Valves and Fittings	Crane Co.
Building Steel	Acme Steel Engineering Co., Balto., Md.
Stick & Breeching	N. Y. Central Iron Works, Hagerstown, Md.
Coal Bunkers	MacNamara & Sons, Balto., Md.

Something Batty in the Furnace

IN THE oil-burner business servicemen come to think parenthetically, which gives them the chance to unload their private opinions concerning customers without jeopardizing the monthly billings.

So it is with Bill Berlin, ace serviceman for Hal C. Ling, G-E air-conditioning dealer in Glen Falls, N. Y. During his career as a trouble shooter he has manfully put up with women who called him in to fix things that wouldn't work (because someone had turned them off) and has patted the heads of Hal C. Ling customers (who perhaps had shovelled sand into mother's fuel tank) and has justifiably won the right to be called courageous and even-tempered.

Recently Bill Berlin was called to a home where the oil burner wouldn't work. "We've had it for more than a year," said the lady of the house, "and this is the first time we've had to give it a thought. Is it out of oil, or something?"

"No," said Bill. (I'll bet your maid set the thermostat down to 55.) That wasn't it. He began a systematic check of the feed line. It was all right. Not particularly disturbed, he disassembled the whole burner, examining each part for defects. There were none, and he put the parts back. In fact, nothing at all was wrong—except that no flame emerged. Hours passed, and even temper gave way to despair and chagrin. Baffled, dejected, and exhausted, Bill let his head hang almost as low as the burner base itself. At that moment he found himself the target of a pair of beady eyes perched just under the nozzle casting of the burner.

Clawing at the apparition, his hand came away with a dead bat. The automatic restart mechanism clicked, and from the nozzle burst the long-missing flame. It was as simple as that. The latest communiqué indicates that everything is once more quiet and parenthetical on the Berlin front.

The bat was one in a million. He went down the chimney, made his devious way into the combustion chamber, and went to roost (and roast) directly in front of the nozzle of the burner.

FIVE PRINCIPAL REQUIREMENTS must be met in the design of hydrogen-cooled turbine generators, according to D. S. Snell of G. E.: 1, a gas-tight enclosing casing must be provided, resistant in an emergency to high internal pressure; 2, the rotating shaft extensions must be sealed against the outward leakage of hydrogen; 3, the hydrogen pressure in the casing must be maintained above atmospheric pressure, to prevent air infiltration; 4, the hydrogen purity in the casing must be maintained at a high value, to ensure non-inflammability of the hydrogen and low windage loses; and 5, there should be, at no time, an explosive mixture of hydrogen and air within the generator or the lubrication system.

It might seem that everything that could be said about the parallel operation of alternators had been covered in the literature on the subject, and perhaps the substance of the discussion presented here exists in one form or another but Mr. Martin's treatment is interesting and may be new to many who are concerned with the operation of alternating current generators. In presenting it, Mr. Martin wishes to acknowledge the assistance and suggestions of R. A. Andrews, E. F. Becker and L. H. Fox of the Ward Leonard Co.

Parallel Operation of Alternators With Cross Current Compensation

BY HENRY C. MARTIN, JR.

Ambos-Jones Co. Manufacturers Representative
Cleveland, Ohio

ALTERNATORS, operating in parallel, must have the same terminal voltage, frequency and approximately the same wave form. After synchronism the generated voltages can and may have to be of different magnitude and the phase relation may differ. The following will explain the effects of the differences in generated voltage in magnitude and phase relation, explaining the reasons for providing automatic cross-current compensation and the proper factors to consider in its adjustment.

The effect of changing the excitation, and consequently the generated voltage of one of two alternators in parallel, is shown in the following vector diagrams. These are drawn at no load and with respect to the series circuit, that is, at a point on the bus, between the alternators, before the load.

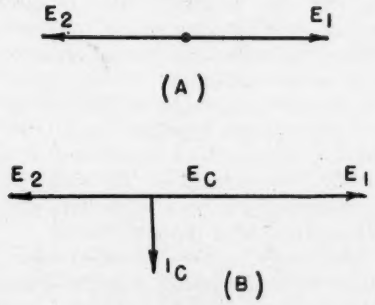


Fig. 1

Figure 1a shows the voltages E_1 and E_2 equal and in phase.

Referring to Figure 1b, if E_1 is increased, there will be a resultant voltage $E_1 + E_2 = E_c$ (vector sum) acting in the series circuit. This causes a circulating current I_c whose magnitude is dependent upon R and X of the series circuit of the armatures. Since X is the major portion of the impedence, I_c lags its voltage E_c by 85 to 90°. Since V_1 and V_2, terminal voltages, must remain equal and in phase opposition, (generator terminals are connected together via bus), the vector diagram takes the form of Fig. 2.

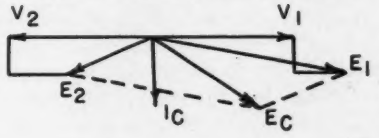


Fig. 2

The circulating current I_c through armature reaction and impedance drops brings about the required equalization in magnitude and phase of V_1 and V_2. Since I_c is lagging E_1 the armature reaction weakens that flux and since it is leading E_2 it strengthens that flux. Due to I_c we now have I^2R losses which are undesirable since they are of no use.

Under load conditions, the vector diagram of two equal alternators in parallel, with the total load divided equally, is shown in Fig. 3 with equal excitation or generated voltages.

The generated voltages E_1 and E_2 are equal, terminal voltages V_1 and V_2 are equal and the total load is I_1-I_2 (vectorially). If the excitation of No. 1 is in-

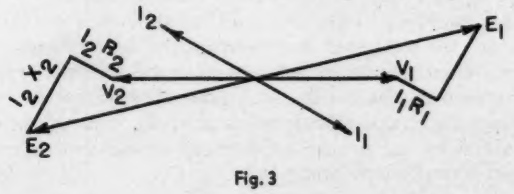


Fig. 3

creased, E_1 lengthening, then the diagram changes to Fig. 4 for the instant.

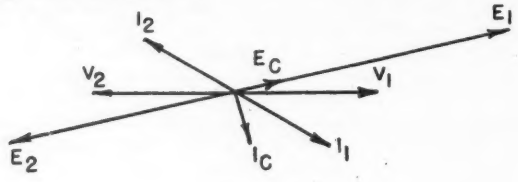


Fig. 4

$E_1 + E_2 = E_c$ which causes a circulating current I_c. The circulating current, again through armature reaction and change in impedance drops, causes an equalization of magnitude and phase opposition in V_1

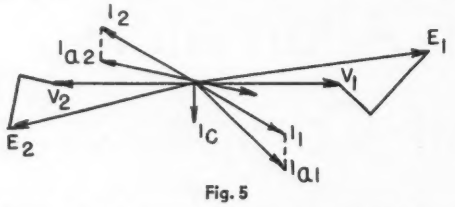


Fig. 5

and V_2 and the diagram takes the form of Fig. 5, as it did in Fig. 2 under no load conditions.

V_1 and V_2 must remain equal in magnitude and must remain in phase opposition. I_1 and I_2 must also remain equal and their total equal to the load. I_1 and I_2 and V_1 and V_2 must remain in the same phase relation because this is determined only by the load. I_c added to I_1 gives I_{a1} (armature current) and increases the copper and iron losses in machine No. 1, proportionally reducing them in No. 2. This is the condition that must be corrected by automatic cross-current compensation and is the only condition that can be controlled thusly.

All previous discussions have been referred to equal alternators with equal constants. The same diagrams would apply to alternators of different ratings whose constants are inversely proportional to their ratings. Under these conditions circulating current is undesirable and unnecessary. However, when the constants are not inversely proportional to the ratings, this circulating current may be necessary to make the

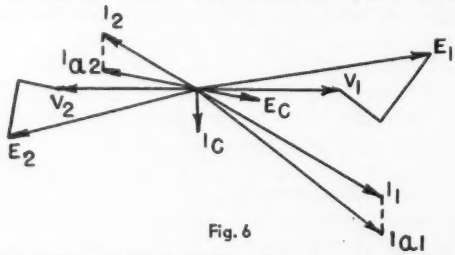


Fig. 6

induced voltages E_1 and E_2 of such magnitude and phase relation that the vector diagram will close. Figure 6 shows the proper adjustment and relation of E_1 and E_2 for the unproportional constants when the governors have been adjusted so the machines share the watt load in proportion to their ratings.

When voltage regulators having automatic cross-current compensation are used, this adjustment of magnitude and phase relation of E_1 and E_2 is obtained by the proper adjustment of the cross-current compensation resistor.

There is a second condition causing a circulating current to flow which is called a synchronizing current. This is caused by a phase displacement and auto-

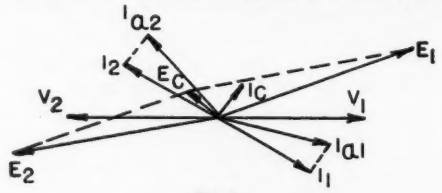


Fig. 7

matically dies out if the governors are properly adjusted.

Figure 3 shows the condition before any tendency for phase displacement takes place. Figure 7 represents the condition when the alternators are slightly out of phase. Machine No. 1 is trying to speed up and has moved ahead of No. 2 several electrical degrees. Consider this to be a momentary swing rather than a steady-state phase displacement.

E_1 and E_2 are out of phase opposition but are still equal since the synchronizing current is still fairly close to the position of phase opposition to E_1 and E_2. and hence armature reaction has not reduced E_1 and E_2. I_c has a large component in phase with E_1 and in opposition to E_2. Consequently it produces generator action in No. 1 and motor action in No. 2. For any fixed setting of the governor, the power output of the prime mover depends on its mean speed and the mean speed does not change with a momentary phase shift of several electrical degrees, so therefore there has been no change in power from the prime mover. The synchronizing current tends to return the phase position, so E_1 and E_2 are in opposition, i. e., synchronism as in Fig. 3. Due to friction and lag in the governors, there may be hunting, but this will be dampened out by copper and iron losses.

The current in the armature of each machine in Fig. 7 is the vector sum of the synchronizing current and the load current. I_{a1} and I_{a2} are the only actual currents with I_c, I_1 and I_2 as only components. The current in the load system is still the resultant of I_1-I_2 which is equal to the resultant of I_{a1}-I_{a2}.

Automatic Cross-Current Compensation

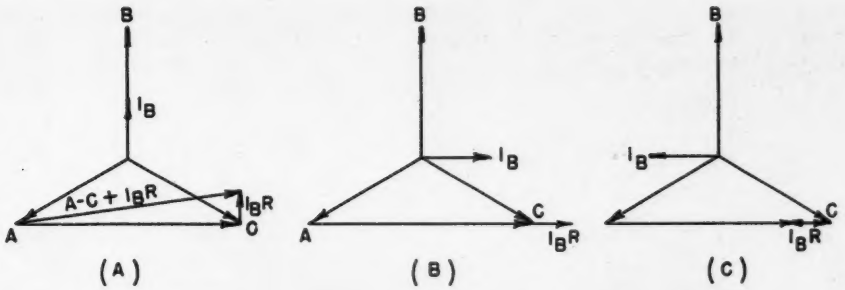
There are two general types of cross-current compensation used with generator voltage regulators. One is called individual compensation and the other differential compensation.

In individual compensation, the voltage-sensitive circuit of the voltage regulator is biased in direct proportion to the reactive current of that alternator. In differential compensation, the bias voltage is in direct proportion only to the relative difference in the reactive currents of the alternators.

The first system causes a considerable droop in bus voltage with increasing reactive load. This is undesirable so the differential circuit is used to prevent this droop.

Consider generator phases as labeled A, B & C. The regulator transformer is connected across the phases A and C with a current transformer connected in the B-phase lead of the generator. Across the secondary of the current transformer is connected an adjustable resistor whose voltage drop will be

Fig. 8



proportional to the line current. The voltage drop across this resistor is connected into the regulator-transformer circuit ahead of the voltage-sensitive element of the voltage regulator so that it adds vectorially to the transformer voltage. Figure 8 shows the diagrams with loads of different power factors.

Figure 8 (a) shows conditions with a unity power factor load. The resistor drop I_BR is at right angles to the voltage across phases A-C. Since this I_BR drop is only a small percentage of A-C, A-C + I_BR is very little larger than A-C. However, in Fig. 8 (b), with zero lagging power factor, the I_BR increases the voltage applied to the voltage regulator causing it to reduce excitation. The opposite effect takes place in Fig. 8 (c) with zero leading power factor.

From the above it is clearly understood that each alternator must automatically adjust excitation so as to share the total reactive current proportionally. Any departure from balance would cause the I_B's to shift their phase positions and initiate corrective excitation, so as to restore balance. It is noted that departure from unity power factor will cause a change in bus voltage when individual compensation is used. Since the load is usually reactive, an increase in load will cause a slight voltage droop.

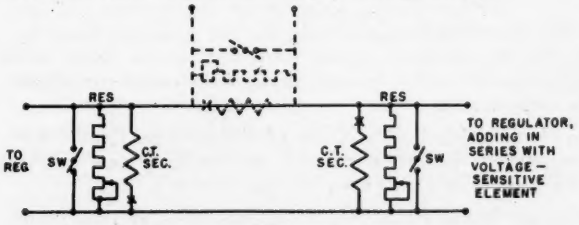


Fig. 9

To counteract this droop, differential compensation is used. To accomplish this, the ends of the cross-current compensation resistors are tied together constituting a symmetrical mesh connection so that all the equal voltage drops are in opposition, when the armature currents of each alternator are equal in magnitude and phase. This, of course, can add nothing to the voltage applied to the regulator and only a change in magnitude or phase relation between alternators can cause any corrective action.

Figure 9 shows this differential connection for two generators. The dotted portion shows the addition of a third unit. More additional units may be added in like manner.

Referring to Fig. 5 we note that I_{a_1} and I_{a_2} are different in magnitude and phase. I_{a_1} causes an increased I_BR drop addition in the regulator circuit so its excitation is reduced while I_{a_2} causes a decrease, increasing its excitation until they are balanced by the differential connection. This returns the vector diagram to Fig. 3.

In Fig. 6 where an unbalance is required, the adjustable resistor permits this.

The proportion in which reactive currents and circulating currents are divided between alternators is determined by the adjustment of the compensating resistor. This adjustment cannot readily be made by observing the A. C. ammeters because they indicate both load currents and circulating currents.

Determine by operation at no-load with cross current compensation cut out and alternators in parallel the relative excitation requirements, i. e., field voltage of the alternators required to give zero circulating currents. Keeping these values in mind, proceed to adjust the compensating resistors, being guided as to correctness of adjustment by the previously observed readings of the alternator field voltmeters only. If after adjusting the resistor to give proper excitation, currents still flow between machines, such currents must be synchronizing currents as shown in Fig. 7. These can be corrected only by governor adjustment.

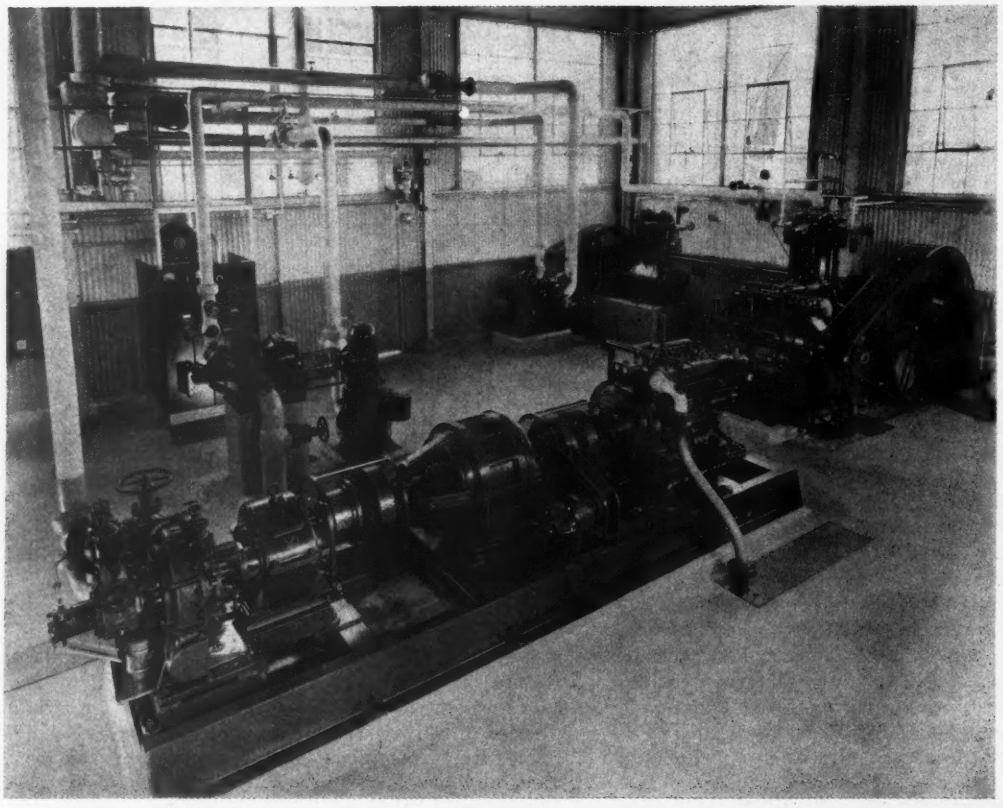
When only one out of two or more alternators with cross current compensation is operating, the cross current switches must be closed, shorting out the I_BR drop. When two or more alternators are operating in parallel, their corresponding switches should be open with the balance of the switches closed.

Summary

Alternators to operate satisfactorily in parallel should have:

1. Same terminal voltage.
2. Same frequency.
3. Approximately the same voltage wave form.
4. Desirable, but not necessary to have constants inversely proportional to ratings.
5. Proper adjustment of excitation to limit circulating currents.
6. Prime movers with same speed vs. load characteristics.
7. Prime movers with drooping speed vs. load characteristics not exceeding 5%.
8. Proper adjustment of governors to divide watt load in proportion to ratings.
9. Flywheel with sufficient WR_2 to give constant angular velocity during each cycle.

Note that generator-voltage regulators can correct only for items 1 and 5. All the other factors are dependent on the generators and their prime movers and governors.



Powered By Gas and Steam

A CALIFORNIA creamery, with intermittent requirements for low pressure steam for processing operations, has effected savings in power costs and at the same time provided adequate protection against power failure, through an ingenious use of gas engine power in combination with steam turbine units.

The engines are installed in the Hanford (California) plant of the Lucerne Cream and Butter Company, and the accompanying illustration presents an excellent view of the installation which was made by the King-Knight Company of San Francisco.

The two gas engines shown are Hercules Model RXLD, 4¾"x5¼" operating at 1200 r.p.m. One of the engines, the one seen at the extreme right in the picture, drives an ammonia compressor in the refrigerating system. This compressor was formerly driven by a 50 hp. electric motor operating on purchased power. Another 40 hp. compressor shown in the corner of this room is driven by a Coppus-geared steam turbine. The engines are used in accordance with the requirements for low-pressure steam for processing operations. When steam is needed the turbine is used. When steam is not required the gas engine drives the compressor.

A similar plan is used in the operation of the generator set, except that in this instance the set is a dual-drive unit, with double extended shaft. The generator can be driven by either the Hercules Engine Model RXLD, which is located at one end of the generator, or by the Coppus-geared steam turbine, which is located at the other end. Under normal conditions the turbine is used for driving the generator when low pressure steam for processing is required and the Hercules engine is used when no steam is needed. However, if the power load increases beyond the capacity of the engine or the turbine, both units can be operated, the turbine taking enough load to give the required of low-pressure steam.

The standard Hercules twin-disc clutch is used for connecting or disconnecting engine and generator, and a flywheel type flexible coupling is installed between engine and generator to give additional flywheel effect. The owners of the plant report that in addition to a lower initial cost of installation, marked operating economies have been achieved. Furthermore, the turbine provides stand-by power for the gas engine, and vice versa.

The PRACTICAL ENGINEER and ELECTRICIAN

R. H. MORRIS, EDITOR

Figures Without Curves

You may have noticed that from time to time we speak of readers instead of subscribers, for we know that many copies of the magazine do double and even triple duty. Just recently we obtained the first positive evidence of what this proportion might be—apparently the average is about two. Up to and through Problem No. 7 (and part of No. 8) of the "How Would You Do It?" contest there have been 279 contest entries from 226 individuals. Of these 129 or about 57 per cent were individual subscribers, a proportion holds true in Questions and Answers department as well.

P. E. & E. is gradually acquiring quite a volunteer staff recruited from the regular P. P. E. regulars. As their names do not appear on the masthead you may be interested in knowing who they are. Earl Noren, when he statistizes as an avocation is doubling in brass so to speak, for he is the fellow who makes most of the mechanical drawings and diagrams used in the magazine.

The cartoons signed e.p.z. are conceived and executed by Eddie Zdanowicz as occasion requires. Between cartoons Eddie fills in rowing a Navy whaleboat around Lake Michigan or with dreams of Admiral Zdanowicz repelling a foreign fleet with his own private battlewagon.

Last, but not least, there is Walter Furman, who takes the miscellaneous articles, sprays them with the comma gun, fits them together like a jig-saw puzzle and arranges the layout. With these three to help and the readers supplying the ideas, the editor leads the life of Riley.

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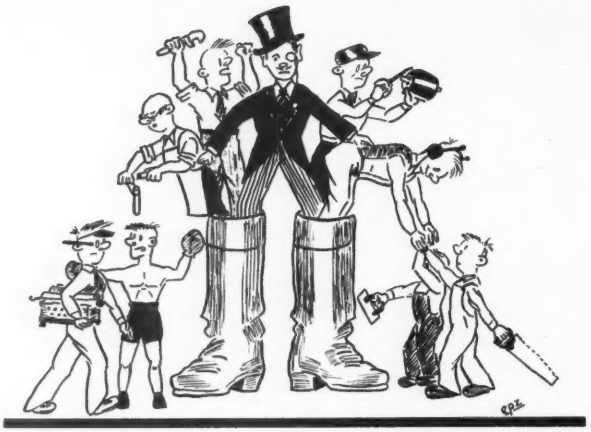


—all in one pair of boots

The Loose Pulley

CATS BEGET CATS and when our Hairy Mountaineer (editorial license for A. W. K. is not hairy but a suave individual, one of the more gentlemanly and civilized mountaineers) last November pulled Nicodemus from the pleasant obscurity of Dan Gutleban's notebook to the fickle spotlight of publicity, he released a flood of cat stories.

Most of these stories are very amusing and caused many a chuckle around the office. The unfortunate part of it all is that they cannot be published, not only is space limited, but because devoting a few inches to nonsense brings in a raft of complaints about the folly of wasting space which might better serve some useful purpose.

Perhaps there is logic in this reasoning, perhaps not, but after all the "little nonsense now and then" proverb has stood the test of time. Even in the face of complaints, however, one of these stories is worth mentioning, not necessarily because it is better than the others but because it serves as a means of relieving the odious routine of "useful purposes" and at the same time gives the opportunity of introducing George H. Wallace.

Back in the days when vacations were like "the letter X in an algebraic equation . . . and . . . the chief had to explain to the Swede foreman what a vacation was because Kanute thought that the only rest a fellow should have was the time spent looking for a job after having lost one," George was pinch-hitting for the chief. Sam Patts, the fireman, had a dog so a power house cat and dog chase was perhaps inevitable.

Anyway they made one lap around the plant and on the second "the cat headed for the door straight ahead . . . and either failed to see the balance wheel of the engine in time or didn't give a damn. With little foresight but the dog for hindsight . . . the cat . . . launched itself into space . . . but didn't have its valves timed right and jumped either too early or too late . . . one of the spokes happened to be in the wrong place at the right time . . . The cat got in front of a spoke, made one trip around the improvised ferris wheel and then, BLAM!! slipped out of the wheel like the release of a dash pot crab, struck the brick wall . . . and gave up 8⅛ of his lives."

After sniffing disappointedly, the dog went back to snooze and the cat lay still for some time but finally got up and wantered around like as though he had "attended a stag party of the Exhibitors Association in Buffalo." A first aid station and good nursing showed no results until "the tenth day he ventured from the hospital but kept a safe distance from the revolving wheel . . . on words of sympathy . . . he twitched the end of his tail almost imperceptibly which showed that he did not need new fuses. He mewed inaudibly when petted, but squirmed from the well-meant caresses and from that day . . . till he was accidently locked in a box car of spare parts . . . walked sideways like a hog to war."

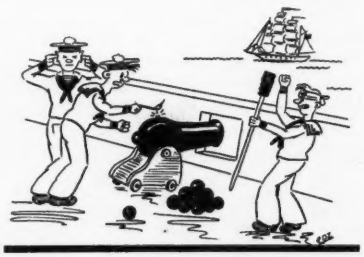
Bill Brewer, who went to Duluth to use the spares for urgent repairs, found the cat when the car was opened. Bill is still around to vouch for the "hog to war" part. The first part is corroborated by Mrs. E. Rankin, a nurse in Waukesha who years ago nursed one of the eyewitnesses' widow "and she told me the same story many times." When she told Mr. Wallace this he asked her to "write this man Kramer and tell him I tell the truth once in a while." His stand is that not even two experienced Wisconsin raconteurs could tell the same story years apart without having some basis of fact to build on.

Certified Proof

As an honored and respected citizen of Waukesha, Wis., no one questions Mr. Wallace's integrity. Still he does have a predilection for tall stories and tells them so skillfully that it is often difficult to separate fact from fancy. His classic story, the Champion Prevaricator (page 198, Feb. 1, 1925) is still remembered and on his frequent and enjoyable visits to the office this is apt to be the title by which he is addressed. On occasion as a member in good standing of the Liars' Club, he "can lie and has a certificate to prove it."

He has been writing for us many years and as far back as 1908, a footnote on one of his articles said: "An experience of 21 yr. beginning, after graduation from college, to a boilermaker's helper, passing to fireman, then to operating engineer and to rearrangement and installation of plants. . . . While his occasional humorous stories stand out prominently, and the majority of his writing has been in a more serious vein, he was for many years one of our consulting staff of Q.&A. experts. While this staff has been discontinued we still call on him frequently for advice and assistance.

His ideas on the mixture of sense and nonsense are reflected in the following observation: "In a magazine of the scope of Power Plant Engineering, you must cater to the best readers in the field you



—the man behind the guns

wish to serve. As years go past, and I have noticed this particularly when on the road, those who saw only the funny side of life have given way to those who feel that they want the more serious things about the profession. If they want mental relaxation, they can get a joke book at the news stand. . . . Still even the Bible has its frivolous moments. . . ."

In the 26 yr. since that footnote of "his 21 yr. experience" was written, as an erector for two of the large engine companies, he has led an adventurous life in many parts of the world, for, in his own words an erecting engineer "must be a diplomat, a prize fighter (if necessary, and it sometimes is), somewhat of a civil, mechanical and electrical engineer, a machinist, a metallurgist, a carpenter, a millwright, a concrete worker and a stenographer—ALL IN ONE PAIR OF BOOTS!"

While we have heard some of his adventures, including a revolution or two first hand, we realized a few weeks ago that we really knew only snatches and very little of the connected story of his life. Feeling that the events, told in his own style, would prove interesting, we asked him to write a biography, having in mind the possibility of using it as a serial.

This was most unfortunate for we thoughtlessly overlooked the fact that for several months he had been seriously ill with angina pectoris. In no uncertain terms he informed us that an obituary was premature for "St. Peter's formal call is a long way off. I rapped him over the head with a 45 Frontier Model the other night and he will stay away a long time." This, we are happy to say, is apparently true for of late he (Mr. Wallace, although we hope St. Peter too) has shown a marked improvement and summer should see him back in the harness.

After explanations and apologies the biography was started "from scratch to see what it would look like. At the bottom of the second page I am not yet in country school. In order to give myself the necessary background, I must note how father when cradling wheat in frontier days was attacked by a flock of Indians. He cut the heads of every one off with the scythe—they had no Indian summer that year!"

But being confined does not stop his correspondence, nor apparently his conversation, for the preacher complains good naturedly that "he talks so much that I have no opportunity to pray for him." His letters are full of reminiscences—the mountain lion who climbed across two conductors of a California transmission line and broiled himself to the inconvenience of all Los Angeles. The Missouri black snake which climbed on a 42 in. belt and came out 6 in. wide instead of 6 in. around. The Ohio dog which inadvertently wagged his tail against the bus and walked like a crooked string bean the rest of his life because he "should have carried a lightning rod." George Rice who shot a cat off the switchboard at the old Commerce Street Station in Milwaukee from the FRONT into the busses and "invented the popular European pastime, the blackout."

The Man Behind the Guns

This military innuendo comes natural for he served in both the Spanish-American and World Wars and has a special liking for the big guns. In his work he gets around a lot and his artillery hobby once brought about a chance meeting on a Pudget Sound steamer which struck our fancy. It led up to a first hand account, by the turret captain involved, of a famous incident, little known outside of Navy circles, in spite of the fact that Sousa wrote a march about it.

During the round the world cruise the U.S.S. Connecticut engaged in a friendly gunnery contest with a British ship and beat them with both 3 and 13 in. guns. "Evans, it's the guns, you got better ones" brought about a bet to prove it was "the man behind the gun." After 3 wk. practice the Yanks made a better score on the English ship with British guns than they had made on the Connecticut in the previous match. The baritone in the band Wallace plays with ("When I'm able to play") was bandmaster on the Connecticut during the trip around the world and tells the same story. It's a small world and George always packs the proof right alongside of the story.

Anyway his biography is something to look forward to. In the meantime there is the rest of the issue to look after before someone yells "We're holding the press for you." For an editor this rolls around once a month, just as insistent in fact as the daily load climbs up each morning on the power plant. This theme is elaborated on in a "pome" sent in by Gene Roberts of Carlsbad, N. Mex. He blames it on some operator and insists he "found it in the waste bag" but we have our suspicions and they are not about the tabby cat in the wheel either. Anyway Gene is a good engineer and a fine fellow whose acquaintance goes back to the days when I was wandering around the Southwest and Mexico years ago after helping to "Save the world for Democracy."

R. H. Morris

STARTING HER UP!

The latch clicks loud as someone tries the door
And Tony who has dozed for many hours,
Looks up, and sees the coming light of day
Make rosy all the sky line in the east.
"By golly, it is time to rise and shine"
He thinks and takes a glim at gauges on the wall,
"The load is building up as fast as sin,
The Diesel's got to roll or hell will pop!"
The air's OK, the cooling pumps turn free,
There's lub in all the cups and fuel on tap.
Without a look for Safety's holy sake
To see if Tabby might be sleeping in the wheel
He opens wide the starting valve and holds his breath.
With awful hiss and clank of frozen steel,
The damn thing wakes to life and grunts,
And snorts like any burdened beast awaked
And Put in chains again for man's caprice.
When up to speed he grabs the D.C. switch
And gets the voltage up with steady hand,
Then sets the plugs and watches the black hand
Till long at last it comes to rest in place.
Then with a prayer and sweating push and shove
He slams the breaker shut—she's on the line!

. . . SHORTS . . .

For safety, electric tools should be provided with a three-conductor cord so that the tool is electrically grounded. When using the tool, it should not be lifted or lowered by use of the cord. Safety demands careful inspection of the tool prior to use and repair of all defects.

* * *

Since the manufacture of wrought iron in India as far back as 3000 B. C., numerous changes in methods of manufacturing have taken place, but the essential characteristics of wrought iron, namely, the purity of the base metal and the included slag have remained unaltered.

* * *

Simple experiments to determine if a lubricant contains corroding substances is to cover steel surfaces with the lubricant, and expose it to the sunlight for about two to three weeks. If the lubricant contains acids the steel surface will show etchings, while water will oxidize the steel and the surface will show rust pits. This should be done with both a highly polished steel surface and a roughly ground surface, as the effect of acid shows up best on a polished surface, while the rusting can be observed better on a rough surface.

* * *

Animal and vegetable fats and oils contain fatty acids which may become free as a result of age and high temperature and are then in a condition to corrode metals. Many vegetable oils become gummy and thicken, thereby losing their lubricating properties.

For ball and roller bearing lubrication, oil is usually recommended for high speeds and grease for slow speeds and heavy loads.

* * *

Temperatures up to 250 deg. F. should not have any appreciable effect upon high-class ball or roller bearing material, but for higher temperatures the ratings or carrying capacity should be reduced.

* * *

While not new, the petrographic microscope, which not only magnifies but produces polarized light, is being used to an increasing extent in the cement, lime, refractory, glass, ceramic and industries using slag. Crystalline materials are identified by measuring optical constants. Examination can be made on powder immersed in oil, on thin sections by transmitted light, or on polished surfaces by reflected light.

* * *

Practical advantages of light weight metals were recently demonstrated when an old bridge, unable to carry the loads of today, was entirely resurfaced with aluminum and the dead load decreased by 750 t.

* * *

About 1½ million tons of lignin, the substance that holds the cellulose fibres of wood together, are produced by the paper and rayon industry annually. This has always been a waste product but research has discovered that a small amount makes cement stronger; it can be used to remove iron from industrial water supplies and by the hydrogenation process it can be converted into wood alcohol and other solvents.

FOR THE PLANT ELECTRICIAN

Cable Heating Eliminates Ice Danger

ROOF AND BUILDING construction often necessitate downspouts for roof drainage with the attendant danger of the frozen spouts, heavy with ice, breaking and causing damage to equipment or danger to life. Elimination of this danger at the Page Avenue Substation in St. Louis was described by J. S. Shaw in a recent issue of the Union Electric Magazine. Formerly large quantities of rock salt were used. This crude method proved to be not always effective and was replaced by a more positive method. Lead covered hotbed wire installed in the drain pipes.

In each 60 ft. downspout, 120 ft. of wire is installed to give a heat release of approximately 800 watts. A thermostat similar to that used for household heat control is calibrated to close at 34 deg. F. and open at 35 deg. F. This is thought to be the initial installation of hotbed cable for downspout heating and has solved the ice problem at this station.

Cable Joints

BECAUSE of the ease and simplicity with which it can be made under emergency conditions, the absence of solder and elimination of the explosion hazard, the non-soldered cable joint can often be used to advantage for voltages of 600 and below. The following directions apply specifically to G.E. mine cable and the numbers in parenthesis identify materials supplied as part of their unit repair packages.

Remove the outer jacket and insulation for a distance of approximately 5 in. from each cable end. Over-lap the two conductor ends as is shown in the drawing, and install two Newberry clamps at the ends of the conductors. The Newberry clamp is a piece of No. 29 ga. wrought iron molded tightly around the conductors by means of tools.

Taper the insulation on each side of the joint, leaving ½ in. of bare conductor between the end of the taper and the edge of the connector. Remove outer jacket and reinforcing braid to final dimensions. Thoroughly clean the surface to which splicing gum is to be applied and cover with a coating of (No. E-399) rubber cement. Allow the solvent to evaporate.

Apply (No. R-363) splicing gum to the dimensions as shown in the drawing below. Cover the splicing gum with one layer of (No. R-36) friction tape, half-lapped and finally wrapped with (5511-4) reinforcing cord.

Taper the ends of the outer rubber jacket and clean the entire surface of the joint. Apply a coating of (No. R-399) rubber cement over the entire joint. When the solvent has evaporated, apply the outer jacket with wrappings of (No. R-387) splicing gum.

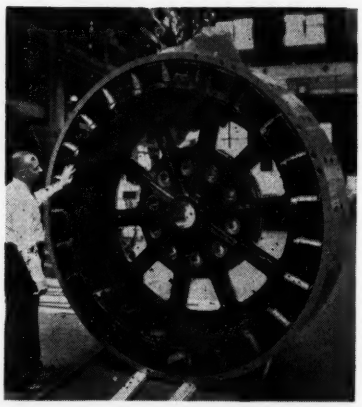
Vulcanize the joint. An emergency method of doing this will be described in the next issue.

Electric Couplings

SEVERAL of the Maritime Commission C-3 cargo boats are equipped with a new form of electric couplings which act as a flexible power transmitting member between the gears and engines and also as a disconnecting clutch. The first of these boats delivered is the M. S. Mormacpenn, built at the Sun Shipbuilding Yards and equipped with four Busch-Selzer 2225 hp., 240 r.p.m. Diesels, driving the screw through Falk gears.

The Westinghouse couplings used act similar to an induction motor, have an efficiency of over 97.5 per cent, and act simply as clutches but do not provide speed control. The inner member has a squirrel cage winding and is mounted on the engine shaft, while the outer part, shown by the photograph is connected to the gear. The interaction of the magnetic fields, one produced by the direct current poles and the other induced on the inner member windings, transmit the power.

Their use as disconnecting clutches is especially useful in multi-engine ships. The usual procedure when near a dock or when maneuvering in a close channel is to run half the engines ahead and half astern. The ship can then be maneuvered in either direction simply by operating a single lever which applies field to the proper couplings, thus connecting the propeller to either the ahead or astern engines as required. The couplings also permit any engine to be shut down for

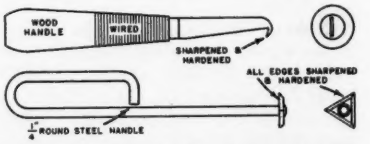


adjustment without having to stop the remaining engines. At the completion of the work, the coupling is energized again, this cranks the engine and it is back in service immediately.

Commutator Maintenance

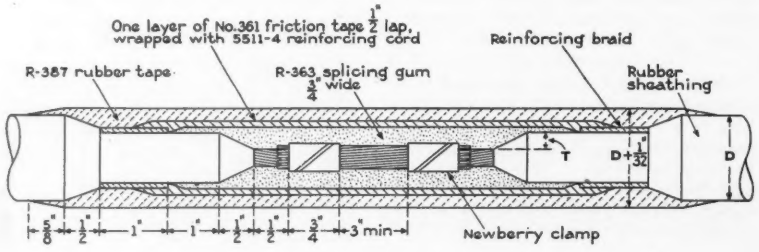
FOR SATISFACTORY operation commutators must be smooth, concentric and properly undercut. Commutator roughness is usually characterized by an abrupt change from one bar to the next as distinguished from an eccentric or egg-shaped commutator. Variations from one bar to the next of as much as 0.0001 in. are sufficient to cause a commutator to perform badly, break brushes or cause excessive brush wear on high speed commutators.

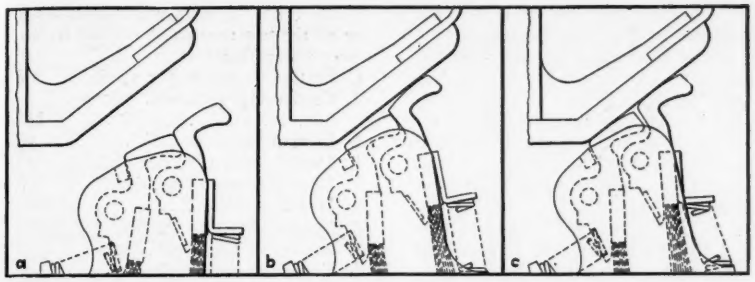
Concentricity of a commutator can be checked with a dial gage mounted on a brush. The surface of a commutator should be concentric within 0.001 in. on commutators whose peripheral speeds are around 5500 ft. per min. and around 9000 ft. per min., to within 0.0005 in. which is about the practical limit for grinding.



Resurfacing should always be done with a grinding rig, whether it is to be ground concentric or in order to remove high bars or flat spots, according to Westinghouse Maintenance Hints. Practically all up to date machines have undercut mica which should be kept $\frac{1}{16}$ in. deep ($\pm \frac{1}{64}$ in.). This can be done by means of a small circular high speed saw about 0.003 in. thicker than the nominal thickness of the mica. In undercutting care must be taken to see that a thin sliver of mica is not left against one side of the slot. Sometimes this sliver must be removed by scraping by hand, handy tools for commutator work being shown by the sketch.

After grinding, undercutting the mica, and beveling the edges of the bars, the commutator surface should be polished, while operating at rated speed. Sandpaper should first be used (never emery)





to remove the burrs due to bevelling, then a very fine grade of sandpaper. A high polish can be obtained by burnishing the commutator with dense felt or canvas. A small amount of light oil can be applied to the canvas if desired to improve the polish.

Magnetic Contactor Refinements

By J. F. Frese
Chief Engineer
Monitor Controller Co.

AS A RESULT of improved design of polyphase contactors it has been possible to extend the capacity from 300 up to 600 and 1200 amps. On test a 1200 amp. contactor made at 550 v., 60 cycles with an air core reactor and currents ranging from 300 to 12,000 amp. showed successful interruption in an arcing time of from 0.53 to 1.4 cycles.

Actuating mechanism is a vertical plunger solenoid with the motion transferred to the contact shaft through a toggle system designed to provide maximum speed in contact opening and maximum pressure when contacts are closed. Rebound is positively prevented by proportioning the momentum and gravity moments of the dropping contactor arms so as to offset the tendency of the solenoid core to start upward after striking the leather shock-absorbing pad.

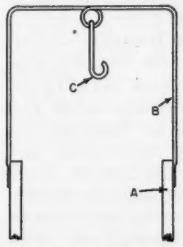
Compact construction of the contacts is obtained by mounting 1-in. wide contact tips one above the other in such relationship that the lower contact makes after, and breaks before, the upper contact as shown by the sketches; a, contacts open; b, contacts closing or opening; and c, contacts closed. Thus the final break of the circuit occurs on the toe of the upper contact, at a point which is not in use during the closed period.

PRACTICAL HINTS AND KINKS

Where Visibility is Poor

By John E. Hyler

TOO MUCH ATTENTION cannot be given to proper lighting conditions, and all equipment should be checked up periodically, to insure that it is in good condition. This is one of the primary rules of safe practice, yet many places that stress safety are negligent in the matter of providing the best in lighting equipment.



Moving cars and other moving carriers, should be painted a color to render them fully visible, and the poorer the natural lighting conditions, the more important this becomes. In many cases, aluminum paint is good for making objects and surroundings more readily visible, and it usually has the advantage of protecting against corrosion to a very high degree, as well.

A scheme that can often be employed to forcibly call the attention to danger is motion of any kind. The human eye is always arrested by motion, and when that can be arranged for without any great expense, it is doubly advantageous. There is shown in the sketch a scheme by means of which a lantern may be suspended above a moving car or string of cars, in such manner as to automatically advise when there is any sudden change of motion, especially starts and stops.

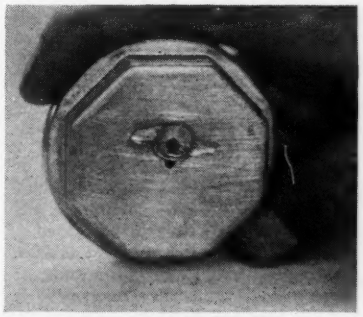
The sketch is intended to convey application to a car, the top parts of the car sides being represented as at A, with a bent rod B fitted so as to span the car and provide an eye. This after being heated and bent to shape, has the ends heated, hammered flat and drilled for screws for attachment to wood. If attached to metal, it may be directly welded to place.

A hook C fashioned from somewhat lighter rod, is fitted with an eye at the top, left sufficiently open for assembly, and then bent shut. The lantern hook at C is fairly well closed, so that a lantern cannot be knocked off of it readily. It is obvious that a lantern hung on a hook free to swing in any direction as shown, will swing and act as a tell-tale when a string of cars is starting or stopping suddenly.

Vent Hole Cover

By Frank Bentley

EVEN LIGHT oils do not flow readily during cold weather and an air vent of some sort is usually necessary in tin cover caps of larger oil cans to allow the small amount of air to enter the can. To keep such a small vent or hole clean and free of dirt when not in use, a shoe blacking can cover lifter can be easily applied to the tin caps of such cans. Put

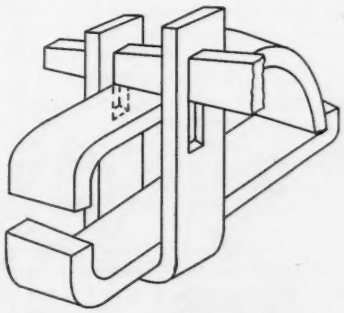


two small holes in the top of the cap, one for a small light rivet to secure the lifter or hole cover and another somewhat larger one for the necessary vent. Space them so that the eccentric turn of the lifter will clear or cover the hole as it is turned. Such lifters are easily procured from an empty shoe blacking box and are so made that they are easily moved with the fingers, even when wearing heavy gloves.

Simple Wedge Clamp

By Chas. H. Willey

HERE is a design of clamp that for certain class of work is very adaptable, useful and instantaneous in operation. And there are many classes of work where a quick release of the clamp is an essential element of the job. Being



wedge operated its action is that of releasing on one blow of the hammer. It has a suitable range of jaw opening due to the design of the lower jaw having two heights of jaw by simply reversing ends, also the width of the slot in the wedge yoke.

Testing Refrigerating Units

By Regis D. Heitchue
Air Conditioning Engineer
Westinghouse Elec. & Mfg. Co.
East Springfield, Mass.

EXACT PERFORMANCE of a complete refrigerating unit is obtained by determining; a, how the efficiency compares with calculated values; b, how much refrigeration is produced as compared to the theoretical value; and, c, how many watts the compressor motor requires when developing this refrigeration. A source of heat and a calorimeter are necessary to obtain this information. Electric energy is ideal for the smaller compressors, but for the larger sizes, such as the 100-ton unit*, steam is more desirable. For this unit it is necessary to supply an amount of heat equivalent to that required to melt 100 t. of ice in 24 hr.

A calorimeter is essentially an evaporator supplying the heat to evaporate the liquid refrigerant which in a refrigerating plant would be evaporated by the substance being cooled, such as air or brine. By measuring the rate at which heat is absorbed by the calorimeter the cooling capacity of the unit is learned.

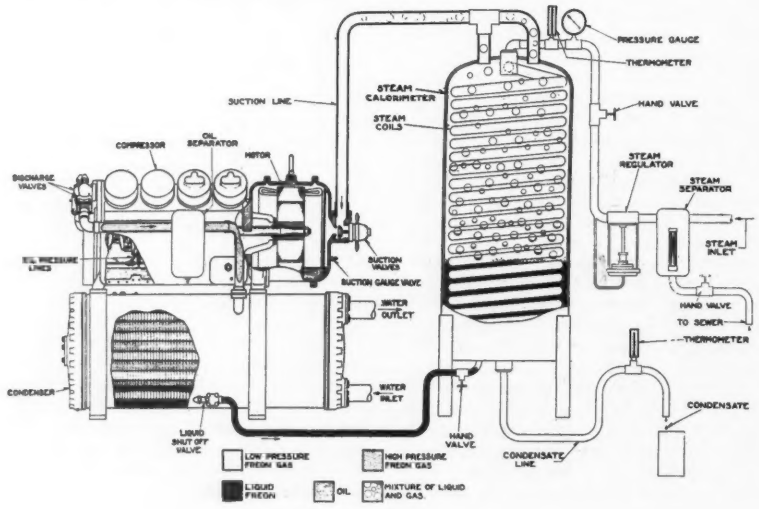
The calorimeter used to test the 100-t. unit consists of a number of coils of copper tubing encased in a steel shell. It is of the semi-flooded type, with the refrigerant enclosed in the shell and surrounding the steam coils. The coils are disposed so as to allow gravity drainage of the condensate. The liquid refrigerant from the condenser is admitted to the shell at the bottom, the flow being controlled by an expansion valve. Evaporation takes place when the liquid comes in contact with the steam heated coils and the gas is then pumped off at the top by the action of the compressor.

The steam for the calorimeter is taken from the main line which supplies heat for the building and steam for manufacturing processes. The steam varies from wet during periods of light load to superheated when the demand is great. It is important that the steam for the calorimeter be dry, since the capacity of the unit is determined by collecting the condensate. To be certain that it is dry, it must be superheated. This is accomplished by first passing the steam drawn from the main line through a separator to remove the entrained water. It is then expanded by a steam regulator from a pressure of around 150 lb. per sq. in. gage to 30 lb. per sq. in. gage. This serves two purposes: first, it maintains a constant pressure; secondly, the adiabatic expansion causes the steam to superheat, since sufficient free water has been removed from the high-pressure steam by the separator. Regulation of the flow of steam is obtained by means of a hand valve. The temperature and pressure of the steam are measured at the entrance to the calorimeter.

Conditions for test are set up by balancing the flow of refrigerant from the condenser against the flow of steam to the calorimeter so that the desired suction pressure and degree of superheat of the suction vapor are obtained. Next, the flow of water through the condenser is adjusted to give the desired outlet water temperature. For the standard rating of condensing units for air conditioning application the specified conditions of pressure and temperature under which the unit is to be tested are as follows: 40 deg. F. evaporating temperature (which for Freon-12 is 37 lb. per sq. in. ga.); 25 deg. F. superheat of the suction vapor; 75 deg. F. entering condenser water temperature; and 95 deg. F. leaving condenser water temperature.

When equilibrium conditions have been maintained for at least an hour, readings are taken of the quantity of steam condensed during an interval of time (by weighing the condensate collected), the steam temperature and pressure, and the condensate temperature. Readings are taken also of the amount and the temperature of the condenser cooling water, watts imput to the compressor motor, suction and discharge pressures, etc. How these data are used to calculate the capacity of the condensing unit is best shown by an example.

*For a description of this interesting unit, in which the suction gas flows through the motor, see Streamlined Air Conditioning, p. 813, December, 1939.



The following data were taken from one of the test records of the 100 horsepower condensing unit:

1.	Suction pres.—lb. per sq. in.	37
2.	Condensing pres.—lb. per sq. in.	113
3.	Suction temp., deg. F.	65
4.	Liquid condenser, deg. F.	75
5.	Discharge gas temp., deg. F.	160
6.	Motor watts	82,700
7.	Condenser water in., deg. F.	75
8.	Condenser water out., deg. F.	95
9.	Condenser water, lb.	1,180
10.	Time, min.	1
11.	Steam pres. lb. per sq. in.	27
12.	Steam temp., deg. F.	300
13.	Condensate, lb.	385
14.	Time, min.	20
15.	Condensate temp., deg. F.	170

EXAMPLE 1. Find the refrigerating effect in B.t.u. per hr? The total heat of the steam entering calorimeter at 27 lb. and 300 deg. F. is 1187.5. The total heat of the condensate is 137.9. This gives a difference of 1049.6 B.t.u. per lb. which represents the amount of heat given up by each pound of steam to evaporate the liquid refrigerant. The test lasted 20 min. so the B.t.u. per hr. is $1049.6 \times 385 \times 60/20 = 1{,}212{,}000$, the refrigerating effect of the condensing unit when the compressor is operated at standard rating conditions.

EXAMPLE 2. Find the B.t.u. rejected to the condenser water? The condenser required 1180 lb. per min. of water, with a temperature rise of from 75 to 95 deg. F. This is $1180 \times 60 = 70{,}800$ lb. per hr. and 70,800 lb. per hr. $\times$ 20 deg. temperature rise is 1,416,000 B.t.u. per hr.

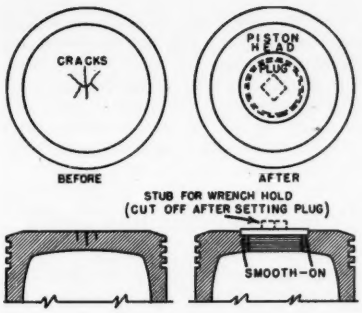
The value obtained from Example 1 could be compared to that from Example 2. In the latter the heat rejected by the condenser is made up of the heat supplied to the calorimeter plus the heat of compression represented by the watts input to the motor. It would seem that if we subtracted the heat of compression from the heat rejected by the condenser the result should be the same as we found in Example 1. Actually this is not so, because of inaccuracies of measurements, radiation and convection of heat from the condenser and compressor to the surrounding air, etc. Good test practice, however, results in an agreement between the two values within about 5 per cent. The diagram shows the compressor, condenser, and calorimeter as they are connected for the test described in this article.

Diesel Piston Repair

By Harold D. Tompkins
Smooth-On Mfg. Co.

BURNING OUT of piston heads is not an uncommon trouble with larger size Diesels. In severe cases some surface metal may not only burn away like grate bars in a furnace, but shrinkage cracks develop and grow with increasing use until they weaken the piston or even extend clear through the head metal and then permit part of the force of the explosion or combustion to pass into the crank case.

The cracks and burning in their earlier stages are almost invariably con-



fined to the center of the piston head surface, ruining this part of the piston, but leaving the rest perfectly sound. Where this has occurred, a practical repair that restores initial strength of the piston and effects a large saving over complete renewal of large pistons, may be made as shown in the sketch.

The weakened head metal is bored out in a lathe and the bore of the opening so formed is tapped to receive a threaded plug with flange, is cast and finished to produce a metal thickness equivalent to that of the metal removed. Any cracks extending outside the bored hole are filled with Smooth-On No. 1. The plug is cast with a top stub for wrench hold, and by means of this stub and a wrench, is forced to a tight fit after the threads and the flange on the plug have been coated with Smooth-On No. 3.

After forcing the plug into a tight fit, the wrench stub is cut off to leave a surface on top of the plug corresponding to the original piston head surface. The Smooth-On iron cement expands in metallizing, thereby giving the repaired piston the same resistance to pressure that it had when new.

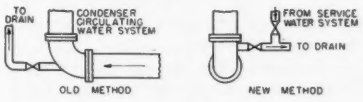
The writer first came into contact with this repair method in a New Jersey shop where six 14 in. pistons of a large Diesel engine were all in the same bad condition and all were being reclaimed in this way. The engineering supervisor in this shop stated that some of these repaired pistons have been operating for over 2 yr. and are still giving good service.

Cooling Water Troubles

With a plant located directly on Lake Michigan with the city water works adjacent, little trouble would be expected with the cooling water supply. Yet Leif Irgens, chief engineer of the Winnetka (Ill.) plant (described on page 562 of the September, 1939, issue) has had difficulties along this line in the past and probably no feature of the new power plant received more careful consideration.

Ice and minnows are the most fertile field for trouble. The first seems to be pretty well taken care of by a separate condenser intake pond, cross connection with the water works intake and recirculation of the warm condenser discharge. To a certain extent this gives some degree of control of the minnows during cold weather when the intake pond can be isolated and operated in a closed circuit with the condenser.

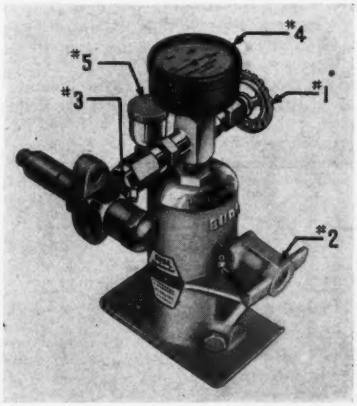
During warm weather this cannot be done, however, and there is no way of eliminating the very small minnows which pass through the comparatively large mesh travelling screens. These fish are small enough so that they cause no particular difficulty in the large tubes of the main condenser but are large enough to be a source of possible trouble in the smaller heat exchange tubes. In accordance with common practice cooling water for these heat exchangers is taken from the discharge of the circulating water pump through twin strainers. Some years ago the minnows were so bad that one man did nothing but clean the strainers continually one night and even with this the unit was kept in service with the greatest difficulty.



The auxiliary water line was taken off the elbow as shown in the sketch at the left, at the point where it is reasonable to suppose the velocity of the water concentrated the minnows. In the new unit the auxiliary connection is taken from the side of the elbow as shown by the sketch at the right, and to make doubly sure, a cross connection is made with the service water system so that when the minnows get too bad the regular circulating water supply can be abandoned temporarily.

Spray Nozzle Tests

Inasmuch as the performance of a given engine depends to a large extent on the adjustment of the fuel injection nozzles, every Diesel plant should have facilities for such tests and adjustments. Commercial testers are available and the following detailed operating instructions apply specifically to the Buda tester. The nozzles should be tested using the regular Diesel fuel oil and it is important that the spray be unobstructed. No attempt should be made to try to retain the used oil and it is particularly important that the hands and face be kept away from the spray.



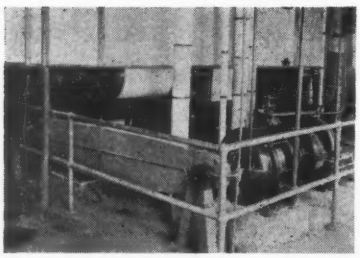
1. Remove plug No. 1 from the end of the coupling.
2. Close relief valve No. 2 by turning to the right.
3. Open valve No. 3.
4. Operate lever socket No. 4 until oil comes out at nozzle connection No. 5.
5. Attach nozzle to nozzle connection No. 5.
6. Operate lever socket No. 4 until gage No. 6 shows the required pressure.
7. Close valve No. 3.
8. Work lever socket No. 4 with quick strokes for a shock test on the nozzle.
9. Open valve No. 3.
10. Operate lever socket No. 4 until gage No. 6 shows the required pressure. If the spring in nozzle releases pressure at this point, nozzle is in proper adjustment and ready for service.
11. Open relief valve No. 2 with the end of the lever bar.
12. Remove nozzle No. 7.
13. Close relief valve No. 2.
14. Replace plug No. 1 in end of coupling.
15. Refill Diesel oil chamber by removing cap No. 8 but only after making sure that the filter screen is clean.
16. Replace cap No. 8.
17. Keep nozzle tester clean and Plug No. 1 in place at all times when not in use.

Turbine and Motors Combined for Synchronized Drive

Turbines have long been used for mechanical drives and to drive electric generators and on printing and soaper range drives now applied in the textile industry, General Electric has combined these two functions. The turbine is coupled to the lead or pacemaking unit and to an a.c. generator. All the other units are motor driven in practical synchronism with the lead because the a.c. frequency varies directly with the turbine speed.

In one application there are eight units in a soaper range, the dry cans are turbine driven and the other seven units are induction motor driven on three floors quite inaccessible for mechanical drive. With the turbine exhaust system heating the dryers, the speed is adjusted to the drying characteristics of the goods in process. The turbine-generator with a chain drive to the dry cans is shown by the photograph.

Induction motor speeds vary somewhat with loads because of normal "slip," a feature which prevents "hogging" the load by any motor and equalizes any pull that may be applied to the fabric. The control is simple and affords ready means for jogging



and for wide range of speed control. In one mill having both printing and soaper ranges driven by this method, the soaper range has been successfully operated at more than 175 yd. per min.

Metal Cutting Costs

COMPARATIVE METAL cutting costs for butane, propane and acetylene based on experiments were presented at the Tulsa S. A. E. meeting by Wm. T. Tiffin, instructor in mechanical engineering, and O. R. Eads, a student, both at the University of Oklahoma. Acetylene, $C_2 H_2$, is the result of a chemical reaction between calcium, carbide and water. Butane and propane are at present byproducts of the gasoline refining process.

In the tests quantities of gas and of oxygen used were determined by weight. The gas drums were direct connected to a common manifold and through a sensitive regulator to the cutting torch. A variable speed cutting machine was used to control the direction and speed of the cut. Cutting speeds were measured with a stop watch. Several practice cuts were made to determine the optimum cutting speed, oxygen and gas pressures.

Three tip sizes were used, designated as No. 1, No. 3 and No. 5. No. 1 tip had four pre-heating holes each 0.039 in. in diam. and one oxygen hole 0.043 in. in diam. No. 3 tip had four pre-heating holes each 0.041 in. in diam. and one oxygen hole 0.067 in in diam. No. 5 tip had four pre-heating holes 0.046 in. in diam. and one oxygen hole 0.081 in. in diam. Cuts were made in steel plate in thicknesses from ⅛ to 1¼ in. Plate cut was according to A.S.T.M. A-70 specification with a tensile strength between 55,000 and 65,000 psi.

Using butane to cut mild steel ⅛ in. thick, the optimum cutting speed was found to be 144.5 ft. per hr. with the torch set at an angle of 19.5 deg. with the vertical and inclined toward the direction of travel. Gas pressure was adjusted by the sensitive regulator and registered about 6 oz. Oxygen pressure was determined at 25 lb. ga. with the No. 1 tip. Gas consumption was 1.05 cu. ft. per hr. and oxygen consumption was 81 cu. ft. per hr.

For acetylene and the same thickness of plate, gas consumed was 9.98 cu. ft. per hr. and the oxygen consumption was 35.6 cu. ft. per hr. The torch angle was 24 deg. off the vertical and inclined toward the direction of travel. Cutting speed was the same as for butane, 144.5 ft. per hr., and the slag formations were similar.

A larger size tip, No. 3, gave better results when using propane. Cutting speed was 94.8 ft. per hr. with the torch inclined 20 deg. from the vertical and toward the direction of travel. Oxygen pressure was the same as for butane, 25 lb. ga. A smooth cut was obtained with propane with practically no slag formation.

Butane gave a smooth cut on ¾ in. thick plate at a cutting speed of 57.9 ft. per hr. No. 1 tip was used at 27 lb. oxygen pressure and with the torch inclined 13.5 deg. from the vertical. On the same material, propane gave a smooth cut with an oxygen pressure of 29 lb. ga. and a cutting speed of 67.8 ft. per hr. The torch was set vertical and the No. 5 tip was used. This same material was cut with acetylene at a cutting speed of 122 ft. per hr. with the oxygen pressure set at 39 lb. ga.

The No. 5 tip was used for all cuts on 1¼ in. thick material and the cutting torch was kept in the vertical position. For butane, the cutting speed was 54 5 ft. per hr. oxygen pressure 32 lb. ga. An excellent smooth clean cut was obtained. Propane gave a smooth cut with slight slag formation. Oxygen pressure was 28 lb. ga. Quality of the cut on the same material was not as high for acetylene. Oxygen pressure was 42 lb.

The table presents in tabular form the data and results obtained in the tests. These figures show acetylene to be cheaper in actual cost per foot but propane gives the smoothest and most desirable cut. The finished cut, using propane, was smooth enough to permit fabrication by welding without expending any labor in cleaning the cut or removing the slag. This slag removal and cleaning of the cut costs money, perhaps enough to more than offset the higher cost of using propane. It might be noticed from the results that the cost of the gas when using either propane or butane is practically negligible.

Comparative Cutting Cost Per Foot for Butane, Propane and Acetylene. Gas costs: butane, 5 ct. per gal. (0.1575 ct. per cu. ft.); propane, 5 ct. per gal. (0.1325 ct. per cu. ft.); acetylene, 1.25 ct. per cu. ft.; oxygen, 1.25 ct. per cu. ft. In the first column B, P and A indicate the gas used, the T1, T3, etc., indicate the tip used

Gas and Tip Used	Thickness in.	Gas c.f.h.	O_2 c.f.h.	Speed ft./hr.	Cut Cost ct./ft.
B2 T1	¾	1.05	81.0	57.97	1.75
B3 T3	1	1.795	112.8	57.2	2.47
B4 T5	1¼	0.723	237.5	54.5	5.45
P6 T5	¾	6.1	203.5	67.8	3.76
P8 T5	1¼	1.21	178.0	64.3	3.48
A9 T1	⅛	9.98	35.6	144.5	0.396
A10 T3	¾	11.11	118.8	122.5	1.33
A11 T3	1	21.95	142 5	85.8	2.39
A13 T5	1¼	26.55	152.25	69.2	3.23

Detecting Ammonia Leaks

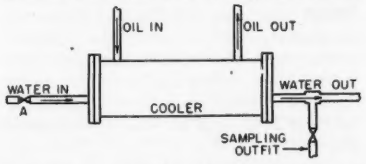
AMMONIA LEAKS can often be located readily in a quiet cooler by sound—an especially valuable method when the fumes are so strong that the usual methods of detecting leaks are difficult to apply. Small leaks can also be detected often by smell, although sulphur candles or sulphur sticks are more convenient and reliable as to exact location. After the approximate location has been found by either method the exact position of the leak may be determined by applying a coating of oil or by coating of thick soapsuds and watching the formation of bubbles.

When burning sulphur is brought in contact with ammonia fumes a very noticeable smoke or cloud is produced. Sulphur sticks used for this purpose can be conveniently made by splitting a white pine block into splinters about an eighth or three-sixteenths of an inch square and 6 or 7 in. long. The sticks should then be dipped into melted sulphur for about 4 in. so that they are thoroughly covered with sulphur. After cooling they are ready for use.

Oil Cooler Leaks

By William Sheffer

LEAKING COILS in oil coolers installed on engines, turbines, etc., may not only endanger the machine itself, but, in the case of small leaks, be a source of continual expense. When the cooling medium is piped away through solid piping, that is, when there is no way of making



a visual inspection of the discharged water, some means of readily sampling the effluent should be devised. Then, at suitable intervals, a sample may be drawn, and examined for traces of oil. The sketch is a suggestion. By closing valve A, an oil leak can readily be determined by opening the sampling valve.

Vibration

IT IS BELIEVED that the ear is the organ which feels vibration and if this is true it is reasonable to assume that there are regions of objectionable or non-objectionable vibration similar to those determined for noise. Tests made some years ago verified these assumptions. A test platform was arranged so that the frequency could be changed from 3 to 70 c.p.s. and the amplitude from 0.00004 to 0.4 in.

Six regions of sensibility were determined: no feeling; slightly sensible; sensible; strongly sensible, or troublesome; disagreeable or probably injurious after a long time; very disagreeable and injurious after a short time. The effect depends to a large extent on the direction of vibration and position of the body. Thus a standing man is more sensitive to vertical than horizontal vibrations, while a man prone on his back suffers more from vibrations transverse than parallel with the body.

Amplitudes that can be felt or that are dangerous are small. At 10 c.p.s. a vibration of as little at 0.00004 in. can be felt and becomes dangerous at 0.008 in. At frequencies of 50 c.p.s. amplitudes of 0.001 in. can be felt and 0.005 are dangerous.

Coarse Aggregate Classification

REVISIONS in the Simplified Practice Recommendation for Coarse Aggregates were recently proposed by the committee in charge which works through the Division of Simplified Practice of the National Bureau of Standards. As reported by the American Public Works Association the revised recommendations are shown by the accompanying table. These cover crushed stone, gravel and slag aggregates from a maximum of 4 in. down to a No. 100 U. S. Sieve series. The Nos. 4, 8, 16, 50 and 100 sieves have openings of 0.187, 0.0937, 0.0469, 0.0117 and 0.0059 in. respectively. Tolerance of the various sieves according to A.S.T.M. Standard C41—36 is plus or minus three per cent for all except the Nos. 50 and 100 sieves which are subject to a tolerance of plus or minus 6 per cent.

Turbine Performance Calculations

By Percy S. Austen

EDITOR'S NOTE: *In his solution of Problem 8 for the "How would you do it?" contest on page 82 of the current issue Mr. Austen the second prize winner used a 150 lb., 70 deg. F. superheat condensing turbine arranged for either extraction or mixed pressure operation at 5 lb. ga. The estimated performance of the turbine under different conditions of operation are shown by Fig. 7 on page 84. As an appendix to his entry, he included the following description of how the curves were calculated. Because the method is covered in some detail, this appendix is published below for the guidance of those who may wish to prepare similar curves for their own use in preliminary calculations and heat balance studies. For later calculations curves should be obtained from turbine manufacturers.*

WILLANS LINE for zero extraction or admission (i.e. straight condensing) was calculated from the data given in the article on Modern Turbines in POWER PLANT ENGINEERING, December, 1937, as modified for decreased efficiency of an extraction machine according to the figures in Economics of High Pressure Steam, POWER PLANT ENGINEERING, April, 1939. The general principle of the turbine performance chart as regards extraction and admission lines and limits of flow is described in the article Modern Turbines, POWER PLANT ENGINEERING, February, 1938.

Vertical distance between the extraction lines is determined by the A. E. F. (Actual Extraction Factor) such that, for the extraction of a given quantity of steam at a certain pressure, the throttle flow to the turbine is increased by an amount equal to the quantity extracted multiplied by the A. E. F. The A. E. F. is determined with the help of Fig. 1 after the T. E. F. (Theoretical Extraction Factor) has been determined as follows:

Consider an ideal turbine in which the expansion is isentropic (constant entropy). The heat content of the steam at throttle conditions, extraction pressure and exhaust pressure can be read off from a Mollier chart for steam. The heat content of the steam that is converted to mechanical energy may be

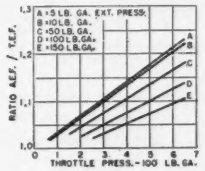


Fig. 1. Extraction factor ratios for condensing-extraction turbines

designated by an area, Fig. 2, in which the vertical dimension represents quantity of steam flow for a given load, without extraction, and the horizontal dimension the difference in the heat content of the steam entering and leaving the turbine. If now, with the same load, a unit quantity of steam is extracted at a certain intermediate pressure, then the throttle flow will be increased less than this amount as indicated by the T. E. F., such that the area A_1 is equal to the area A_2.

Let a=heat content of steam at throttle.

b=heat content of steam at extraction pressure (ideal turbine).

Size number	Nominal square openings[1]	Amounts finer than each laboratory sieve (square openings), per cent by weight													
		3-1/2 in.	3 in.	2-1/2 in.	2 in.	1-1/2 in.	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8	No. 16	No. 50	No. 100
1	3-1/2 to 1-1/2	90-100[2]	...	25- 60	.....	0- 15	.....	0- 15	.....	.....	.....	.....	....	....	.....
2	2-1/2 to 1-1/2	.....	100	90-100	35- 70	0- 15	.....	0- 15	.....	.....	.....	.....	....	....	.....
24 ...	2-1/2 to 3/4 ...	.....	100	90-100	.....	25- 60	.....	0- 10	0- 5	.....	.....	.....	....	....	.....
3	2 to 1	.....	...	100	90-100	35- 70	0- 15	.....	0- 5	.....	.....	.....	....	....	.....
357 ..	2 to No. 4	.....	...	100	95-100	.....	35- 70	.....	10- 30	.....	0- 5	.....	....	....	.....
4	1-1/2 to 3/4 ...	.....	...	.....	100	90-100	20- 55	0- 15	.....	0- 5	.....	.....	....	....	.....
467 ..	1-1/2 to No. 4 .	.....	...	.....	100	95-100	.....	35- 70	.....	10- 30	0- 5	.....	....	....	.....
5	1 to 3/8	.....	...	.....	.....	100	90-100	40- 75	15- 35	0- 15	0- 5	.....	....	....	.....
57 ...	1 to No. 4	.....	...	.....	.....	100	90-100	.....	25- 60	.....	0- 10	0- 5	....	....	.....
6	3/4 to 3/8	.....	...	.....	.....	.....	100	90-100	20- 55	0- 15	0- 5	.....	....	....	.....
67 ...	3/4 to No. 4 ...	.....	...	.....	.....	.....	100	90-100	.....	20- 55	0- 10	0- 5	....	....	.....
68 ...	3/4 to No. 8 ...	.....	...	.....	.....	.....	100	90-100	.....	30- 65	5- 25	0- 5	....	....	.....
7	1/2 to No. 4 ...	.....	...	.....	.....	.....	.....	100	90-100	40- 70	0- 15	0- 5	....	....	.....
79 ...	1/2 to No. 8 ...	.....	...	.....	.....	.....	.....	100	90-100	40- 75	5- 25	0- 5	....	....	.....
8	3/8 to No. 8 ...	.....	...	.....	.....	.....	.....	.....	100	85-100	10- 30	0-10	....	....	.....
9	No. 4 to No. 16.	.....	...	.....	.....	.....	.....	.....	.....	100	85-100	10-40	0-10	....	.....
10 ...	No. 4 to 0[3] ...	.....	...	.....	.....	.....	.....	.....	.....	100	85-100	.....	....	....	10-30
G1[4] ..	1-1/2 to No. 50.	.....	...	.....	.....	100	80-100	.....	50- 85	.....	20- 40	15-35	5-25	0-10	0- 2
G2[4] ..	1-1/2 to No. 8 .	.....	...	.....	.....	100	65-100	.....	35- 75	.....	10- 35	0-10	0- 5	....	.....
G3[4] ..	1-1/2 to No. 4 .	.....	...	.....	.....	100	60- 95	.....	25- 50	.....	0- 15	0- 5	....	....	.....

Recommended classification of coarse aggregates—crushed stone gravel and slag. Notes: [1]Sizes given are in inches down to 3/8 in. and from there on numbers of the U. S. Standard sieve series. [2]100 per cent finer than 4 in. [3]Screenings. [4]Requirements for grading depend upon the percentage of crushed particles in the gravel; G1 is for gravel containing 20 per cent or less of crushed particles; G2 is for from 20 to 40 per cent crushed particles and G3 is for crushed particles in excess of 40 per cent.

c=heat content of steam at exhaust pressure (ideal turbine). Then

T.E.F. (a-b) = (1-T.E.F.)×(b-c)

or T.E.F. = (b-c)/(a-c).

From Fig. 1 the value of A.E.F./T.E.F. is read off and the Actual Extraction Factor determined as follows:

T.E.F. × A.E.F./T.E.F. = A.E.F.

When a turbine operates so that extraction or admission of steam occur at approximately the same pressure then the spacing of the admission lines is often the same as the spacing of the extraction lines. The extraction and admission lines of an actual machine may vary somewhat from the determination of these lines as described above, but this method is ordinarily satisfactory for preliminary estimates.

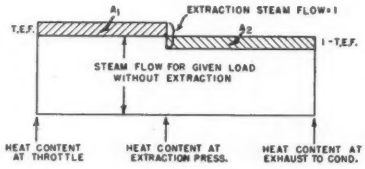


Fig. 2. Change in steam flow and energy conversion accompanying for an ideal turbine

EXAMPLE

The following computations are for the turbo-generator in Problem No. 8:

Heat content of steam at throttle, 150 lb. ga., 70 deg. sup. = 1237 B.t.u./lb.

Heat content of steam at extr. point, 5.3 lb. ga. (ideal turb.) = 1072 B.t.u./lb.

Heat content of steam at exhaust, 28½ in. Hg. vac. (ideal turb.) = 884 B.t.u./lb.

Theoretical steam rate = 3413/(1237 — 884) = 9.67 lb. per kw-hr.

Actual steam rate at full load, = 9.67 × 1.68 × 1.03 = 16.73 lb./kw-hr.

Actual steam rate at half load, = 9.67 × 1.88 × 1.06 = 19.28 lb./kw-hr.

T.E.F. = (1072 — 884)/(1237 — 884) = 0.533.

A.E.F.=0.533 x 1.05=.560

Computation for location of approximate actual expansion line on Mollier steam chart:

Full load shaft power steam rate= 16.73 x Eff. of generator

=16.73 x 0.94=15.73

Let a=heat content of steam at throttle.

b^1=heat content of steam at extr. point (actual turbine).

c^1=heat content of steam at exhaust to condenser (actual turbine).

then c^1=1237-3413/15.73=1020

This means about 7.8 per cent moisture.

A.E.F. $(a-b^1)=(1-A.E.F.)\times(b^1-c^1)$

or b^1=A.E.F. $(a-c^1) + c^1$

=.560 (1237-1020) + 1020

=1142 with about 1½ per cent moisture.

Since 10 to 12 per cent moisture in the turbine exhaust is generally considered the maximum for satisfactory operation, it would appear that the steam conditions are satisfactory for the above machine.

Questions And Answers

Heating Value of Wood

AS A RESULT of the hurricane last fall we have been burning fresh cut white pine in both low and high pressure boilers. Can you give me an idea of the heating value per pound of this wood as fired?

A. H. PARKER

Peterborough, N. H.

Heating values given for wood vary over a considerable range depending primarily on the rosin content. Freshly cut pine will have a moisture content of from 50 to 60 per cent, will weigh about 3300 lb. per cord and have a heating value of about 4250 B.t.u. per lb. Air dried, the moisture runs around 25 per cent, the weight about 2200 lb. per cord and the heating value about 5850 B.t.u. per lb.

What Engineers Read

WHAT, HOW AND WHY the other fellow does things is apparently a matter of primary importance to engineers. Recently C. W. Roth of the Republic Steel Co. conducted a survey of reading habits among 506 key men of the steel mills, manufacturing plants and officers of the company, with very interesting results. Among 228 in the steel mill group, mostly engineers, 73.7 per cent considered industrial or professional magazines essential; 77.6 per cent interesting; and 78.8 per cent valuable.

Some 68.4 per cent subscribe or have requested one or more publications, 44.7 per cent, two or more; 28.5 per cent, three or more; and 32.7 per cent, more than three. However, they make good use of the other fellow's magazines for they regularly read more than this, the corresponding percentages being 84.4, 68.6 and 48.9. Almost one-third read more than three publications regularly. It is also evident that they exercise considerable discrimination in what they read and pass over many without reading, for 95 per cent regularly receive one or more publications; 87 per cent, two or more; and 75 per cent, three or more.

Among the subdivisions, the safety and industrial relations men read most, averaging 2.91 publications; the maintenance men are next with 1.82; the general engineering group average 1.31 and the supervisors come lowest and average only 0.73.

Of the whole group 83.3 per cent read the advertising; 72.4 per cent buy or requisition advertised products; 71.5 feel that this advertising builds confidence in the integrity of the company and quality of the product so that it would influence their decision when dealing with a new company; and 58.4 per cent maintain a regular literature and catalog file. Inasmuch as the questionnaires were sent in voluntarily and not signed, there can be little question as to their accuracy.

As publishers and editors this data, particularly on the number of papers read, is interesting to us and we felt would be to many of our own readers. If sufficient interest is evinced more complete data on the survey will be printed or the questionnaire reproduced for those who may wish to do something along the same line in their own company. Data collected in connection with our own questions and answers department and contest show that between 50 and 60 per cent participating are individual subscribers, indicating that each copy does at least double duty.

Oil Difficulties in a Refrigerating Plant

ON PAGE 80 of the February issue G. R. W. asked how to rid a refrigeration system of the oil, how to prevent oil from reaching the heat transfer surfaces in the future, and how to stop oil pumping by the compressor. Our original answer is given below, followed by other replies to the questions as printed.

We assume that your system includes oil interceptors or separators, traps and oil drains from the liquid receiver and that you drain them periodically. In this case you are probably interested in removing the oil film from your condensers and evaporating surfaces. Excessive amounts of good low pour point oil can often be blown from the evaporator coils by closing the expansion valves, pumping out and then opening the expansion valve wide several times. The only way we know of cleaning the remaining oil film from either the evaporator or condenser is blowing them out with steam and then thoroughly drying with air before putting them back in service.

* * *

THE METHOD suggested above for cleaning the oil from condenser and evaporator surfaces is O. K. if they are thoroughly dried afterward. Com-

pressed air tends to carry along moisture brought in from the atmosphere, and unless this air is heated or the pipes are dried in some other way, water will remain in them. If the pipes can be disconnected at the joints and exposed to the sun in warm, dry weather, the excess moisture is easily eliminated.

With modern lubricating oils there is much less danger of coating the inside of the coil with a heavy film, that would cut down heat transfer, than heretofore. With proper oil, the boiling action of the ammonia keeps the pipes pretty well cleaned inside. Oil mixed with the ammonia does, of course, change the evaporating temperature, for a given pressure. Also, the oil tends to slow down the flow of ammonia in a cold pipe. For these reasons it is advisable to catch the oil in a separator of ample size. Some of the separators now have cooling coils inside of them as a means of stopping the oil more effectively.

If a compressor is pumping too much oil, the trouble can often be cured by the use of scraper-type rings at the bottom of the piston, holes being drilled behind the ring to drain out the oil collected by them. Other cases of oil pumping are cured by the installation of a forced feed oil system on the machine, after which the level of the oil can be carried so low that the cranks do not splash in the lubricant.

The tendency of a machine to pump oil under low suction pressure can also be gotten away from by the installation of a booster machine in the system.

TERRY MITCHELL.

* * *

OIL in the evaporating coils may be removed by first pumping refrigerant to high side of system and blowing coils out with air. This will remove most of oil in cooling coils. He should put the compressor in best possible condition as to rings, valves, etc. A good grade of ice machine oil should be used and to prevent oil from reaching heat transfer surfaces in future a good oil trap should be installed if it is not there already. This trap should be in the discharge line from compressor as close to the condenser as possible, and should be blown out as often as necessary. If this is done he will have no more trouble with oil.

Gaylord, Mich. O. J. PIERESON.

* * *

Suggestions were also received from: William Musial, Chicago, Ill.; A. G. Solomon, Bradbury Heights, Md.; C. C. Collins, Redmond, Ore.; and Carl Egerter, New York, N. Y. They will be published later.

Condensate Pump Trouble

ON PAGE 82 of the February issue W. P. C. wanted to know why he was having trouble with the valve springs of a condensate pump on his Buffalovac milk dryer. The following suggestions have been received:

ABOUT 2 yr. ago I had about the same problem as W. P. C. except mine was in a paper mill instead of a creamery. I have a 5¾ by 6 by 6 in. duplex steam pump which broke valve stems too regularly for comfort. After trying everything I could think of without success I finally decided that the hot water must flash into steam at times and the pump race, thus breaking the valve stem. I drilled and tapped a ½ in. cold water line into the suction line just before it reached the pump and have not had any trouble since, which was about 2 yr. ago.

D. G. SIMMONS.

Stuyvesant, N. Y.

* * *

IN A SIMILAR situation I found that by installing a 1 in. Coe Drainator on each roll we obtained a lower percentage of moisture in the milk powder and our return was quite satisfactory. Our mill was about 150 ft. from the hot well and 70 lb. ga. pressure was used on the rolls. If such an arrangement would not be satisfactory in W. P. C.'s case I suggest the installation of an automatic pump and receiver. The pump could be either steam or electric, if the receiver tank should be 18 in. dia. and 30 in. long arranged with a float connected to control the water level in the tank and with traps on each roll discharging into the tank. I can see no reason why the traps close on each roll would not take care of this situation, with 70 lb. pressure on the rolls, which is necessary to dry milk.

Gaylord, Mich. O. J. PIERESON.

* * *

SUGGEST replacing the reciprocating pump with either an electric or steam turbine driven centrifugal pump of the type made by an Allis-Chalmers or Worthington, etc., the manufacturer will readily supply the exact size and type to fit your need. In case of an Allis-Chalmers selection, I think that a type S 3 by 2 or 4 by 3 would be recommended.

Baltimore, Md. C. W. PARKS.

* * *

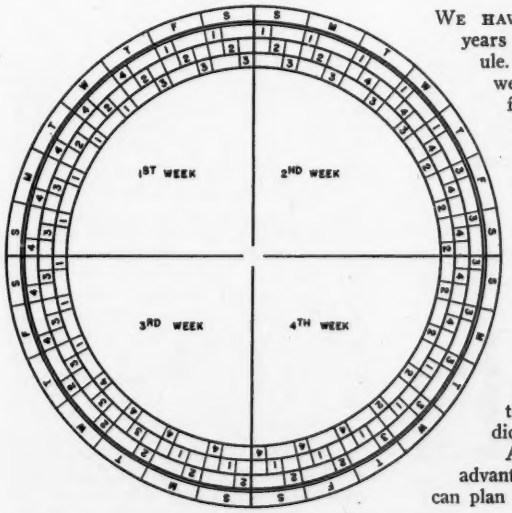
BEFORE we could recommend a definite size of pump for your subscriber it will be necessary for us to have complete details, particularly with regard to the operating vacuum and the piping hook-up.

Manager, W. M. THOMSON.
Industrial Division,
Nash Eng. Co.,
So. Norwalk, Conn.

* * *

BELIEVE that this difficulty could be overcome by submerging the discharge valve with condensate as undoubtedly

The Work Schedule



WE HAVE used for a number of years in a revolving 4 wk. schedule. This applies for seven day week operation and provides for four shifts or crews. In this schedule each man has from Thursday until the following Tuesday off every 4 wks., two full days off once a month, and one free day at another period. It results in a five day week for three weeks, and a six day week the fourth week, averaging 42 hrs.

The day is broken into three eight-hour shifts with the shift or crew number indicated as 1, 2, 3 and 4.

A schedule of this nature is advantageous to a man in that he can plan a definite weekend off once every 4 wks. with sufficient time to really go places. This chart is much more easily comprehended if colors can be used rather than numbers for each of the four shifts. Our men are very enthusiastic over this plan and figure their vacation or off period montths ahead.

H. W. GOCHNAUER,
Chief Engineer.
Northern Paper Mills
Green Bay, Wis.

* * *

The above is a reply to J. M.'s question on p. 542 of the August issue. Work schedules were published on p. 610, September; p. 676, October; and p. 736, November. Schedules were also sent in by the following and will be used later: August J. Ludwig, Dundalk, Md.; Clinton Miller, Covington, Ky.; Albert W. MacFarland, Bordentown, N. Y.; J. R. Harley, Parris Island, S. C.; G. R. Redman, Chicago, Ill.; Chester Wolf, Washburn, Wis.; J. DeMois, New York, N. Y.; Jas. L. Goodwin, Los Angeles, Cal.; M. J. Werdung, Peru, Ill.; A. Fenton, Brooklyn, N. Y.; E. W. Robinson, Amarillo, Tex.; C. Brooks Hudson, Plymouth, Mass.; Francis M. Newell, Wilmington, Del.

air leakage takes place at the discharge end of the pump.

M. J. K.

* * *

WE HAVE furnished steam driven pumps for many years in connection with Buffalovac equipment, and they have proven satisfactory in every way. As a general rule, we have found that whenever trouble does start on a job of this kind, that it is usually due to the fact that some of the parts of the pump require replacement, or it may be due to improper care or improper installation.

Your client's trouble may be caused by the pump valves being worn or perhaps it is the piston packing which should be replaced or a combination of the two. If this is the condition, then enough slippage would take place to cause the pump to operate at an excessive speed, resulting in the valve stem breakage.

A suggestion to overcome their trouble would be to furnish the valve stems of steel, or perhaps stainless steel, instead of the regular bronze, which is standard. We feel that before this is done they should check into the condition of the valves and packing. When a piston type pump is used on one of these systems, there must be a sufficient head on the suction to prevent flashing to a vapor. The same thing is true of a centrifugal. In view of the many things that might be wrong, may we suggest a sketch showing the installation.

W. B. N.

* * *

SINCE there appears to be no reason why the pump should not be operated intermittently, I would suggest a centrifugal motor pump taking its suction from a small storage tank and operated automatically by a float switch. Most well known pump manufacturers have such a unit completely fabricated.

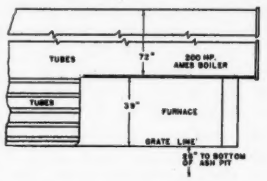
If the initial outlay is not as important as 100 per cent service factor, he may have the tank provided with twin motor pumps and, through a selective switch, operate either unit while the other is available for standby or repair. A typical unit would be twin Ingersoll-Rand Motorpumps, size 2RV5, 50 g.p.m. The head should be given or enough data furnished the manufacturer to arrive at this figure so that the correct pump and motor might be selected.

Dresden, N. Y. W. F. CANTIERI.

Alarm Circuits

MORE than 20 replies were received to C. E.'s question about High Water Alarm Circuits published on p. 81 of the February issue. They are still coming in so that it has not been possible to classify them all to eliminate duplication. While the majority complied with C. E.'s request that the relay circuits and float contact operate at 6 v. and the light and bell at 110 v., several sent in circuits which they use with only a single voltage.

Help Needed on Hogged Fuel



UP IN NEW YORK STATE, G.L.B. burns green veneer waste (about 40 per cent moisture) and some bark under a 200 h.p. Ames firetube boiler. The grates are about 26 in. above the bottom of the ash pit and the furnace height is about 39 in. The wood and bark are hogged in a machine that pulls about 30 hp. He has received a lot of conflicting advice as to how improvements can be made: furnace is too small and boiler should be raised 2 ft.; the front of the furnace should be moved out 2 fit.; unhogged fuel should be fed through a trap in the side of the furnace to eliminate the 30 hp. hog-motor load; agitators should be installed to loosen the fuel on the grates. All in all G.L.B. is just a bit puzzled and would like to know the experience and opinion of engineers who are now burning wet wood waste.

The advisability of using the 6 v. on open float contacts is evident, closed switches are available and apparently the single voltage is widely used. Obviously by using the proper relays, lamp and alarm any voltage, a.c. or d.c. can be used on any of the circuits. Using a single voltage everything can be accomplished with one relay, while two relays are required with two voltages. Some of the circuits sent in use three and four relays.

Oddly enough the first circuit to arrive was also the simplest and is described below:

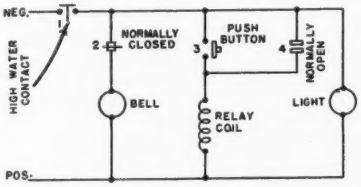


Fig. 1

"A SCHEME used by our company on bell alarm cutouts (Fig. 1) may solve his problem. Only one relay is needed, this having a normally closed back contact and a normally open front contact. When the high water contacts make, the bell is immediately energized through contact 2. To stop the bell the operator pushes push button 3 which picks up the relay and locks it in by contact 4 and opens contact 2 to de-energize the bell. The lamp is on as long as high water contacts are made and the relay drops open when the high water contacts are opened."

HARRELL DENMEAD.

Pittsburgh, Pa.

* * *

This circuit like all the others of course can be used as an alarm on any

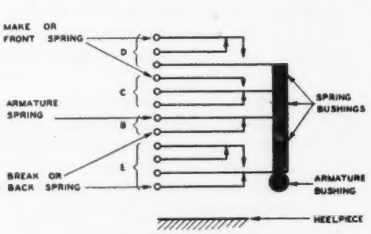


Fig. 2

service and is not confined to the use of float switches or other water level actuated devices. Mr. Holden used a different, but the same circuit as Fig. 1. Referring specifically to the float valve construction he says:

"PLACE a snap acting mercury switch on top of the water tank for float oper-

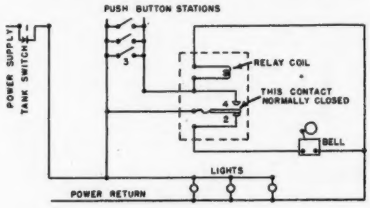


Fig. 3

ating. Anchor a stand pipe in the tank, for the float to ride up and down in, so as to hold it plumb with the switch lever, the stand pipe to be perforated with holes for water to follow the tank water level. The rod should have two adjusting collars, made secure with set screws, so that the water level can be held at any height in tank that is desired."

G. M. HOLDEN.

Arlington, Calif.

* * *

Relays are made in a wide variety of sizes, shapes and design for practically all voltages, a.c. or d.c., fast or slow opening or closing, mechanically locked in or out, single winding, double winding, differential, polarized, the equivalent of single pole, single throw, double pole double throw, etc. The most flexible and versatile, although limited to a maximum of 1 or 2 amp. is the small telephone or radio type.

By building up small spring contacts a great variety of combinations can be obtained with a single armature. Figure 2 is an example of spring combinations possible in an Automatic Electric Type A relay. A "make" assembly is just the reverse of the "break" or B combination of Fig. 2. C is a "break-make" assembly; D a "make-before-break"; and E a "break-make-before-break."

Because relay circuits are so widely used drawings have become highly conventionalized and it is often difficult for one experienced with one set of conven-

tions to interpret another. Fig. 3, for instance, is basically the same as Fig. 1, except that several push buttons and lamps are used, a highly desirable feature in many locations. For convenience the contacts have been numbered the same as Fig. 1, and the same explanation holds. Other portions of Mr. Graham's reply follow:

"THE RELAY may be home-made from a 110 v. a.c. bell or one of the commercial types may be used, such as those manufactured by Cutler-Hammer, Ward Leonard, Square 'D,' Gardner, Eagle, Signal, or Dunco. A most likely place to obtain these relays is the amateur radio supply stores. The relay is essentially a single pole, double throw switch using gravity or a spring to keep one contact closed. This contact is used in the bell circuit as shown in the sketch.

"As to the float switch, I suggest it be selected with care. One having in its construction a differential feature will allow the ordinary variations in water level without sounding the alarm . . . the push button stations may be as many as C. E. wishes to wire. These are momentary contact switches or high voltage bell pushes."

JOHN A. GRAHAM.
Shady Side Academy,
Pittsburgh, Pa.

* * *

Replies were also received from: James O. G. Gibbons, Bloomfield, N. J.; R. C. Roetger, New York, N. Y.; Milton N. Kraus, New York, N. Y.; W. A. Mueller, Decatur, Ill.; Donald Osterhoudt, Poughkeepsie, N. Y.; L. O. O'Brien, Minneapolis, Minn.; Raymond Smessaert, Chicago, Ill.; Leslie Bradley, Dakota Public Service Co., Bismarck, N. D.; A. R. Markland, Altoona School District, Altoona, Pa.; Bill Maddock, Tuscon, Ariz.; Joseph J. Buffone, Clifton, N. J.; Edward N. Wright, Leominster, Mass.; Alan Knox, Carlsbad, Cal.; L. W. Geier, Milwaukee, Wis., and Frank Brigham, Port Angeles, Wash. While there is considerable duplication, many of these have specific recommendations of interest and will be used later.

Letters and Comments

More Problem VI

ANSWERS to Problem VI (page 83 February) have missed the point of bacterial action in the filling water in the system. There are several forms that produce gas from organic matter and iron salts in the water. The bacteria in sewage sludge will create pressure enough to split cast iron pipe if closed off tight. This action can be stopped by a dose of chlorine when filling the system. If the pressure rise stopped after 6 months or a year it would confirm this bacterial action.

Jackson, Mich. J. TARBALL.

"It's Purely Coincidental" As the Movies Say

DON'T HURRY WATER by George P. Pearse on page 66 of the February issue was most enthusiastically pointed out to us by our operating engineer because of the analogy in names and possible conditions. Before I go any farther, let me state that I have *no* brother-in-law who is the manager of an institution similar to that which Mr. George Pearse mentions, so "that particular shoe does not fit."

We certainly agree with Joe that the 40 hp. centrifugal pumping unit for the conditions outlined in this article was over-sized, uneconomical and apparently unsuited to the conditions. Joe was heading in the right direction when he talked about improved power factor and greater storage. In fact, I would go just a little bit farther and provide for a storage tank of 120,000 gal., sufficiently large to take a day's supply in case of main or pump breadown and to provide reserve in case of fire, presuming that an institution large enough to use this quantity of water must have some fire protection.

Instead of cramping our style with a 5 hp. pump, I would step this up to 10 hp. which would not approach the ideal that Joe sets up for constant pumpage and low demand to average ratio, but certainly would be better than the 40 hp. mentioned by your Mr. Fritz. You will note that the 10 hp. centrifgual unit would take care of the 8-hr. drawdown, without storage. This allows a reserve for fire protection and permits taking advantage of off-peak power rates or the use of the institution's power when other power load is a minimum.

All of that is well and good. We will condemn our namesake for an uneconomical design. We will indicate that Joe is heading in the right direction even though he has sliced his reserve storage a little too thin. *However*, we are wondering if Mr. Pearse and the editor have not taken certain liberties with hypothetical features which certainly should be considered in institutional water supply.

For instance, if Mr. Pearse thinks it desirable to refer to the principals in the case by name and to the farm as the "old Wycroft farm" I think it would be mighty desirable to give us some more facts about the institution and the farm before the hypothetical manager be permitted to accuse himself of stupidity.

It occurs to me that 112,000 gal. per day consumption might indicate general use of the water supply. Let me ask to what extent should this supply be made fit for human consumption, or fit for boilers or condensers? And second and most important, I am wondering how big the "old Wycroft farm" might be to support drawdown of 112,000 gal. daily which equals 15,000 cu. ft. which in turn is equal to four acre inches per day.

Just consider for a moment that certain humid sections of these United States have undergone prolonged droughts in the last 10 yr. and we wouldn't be surprised that Joe's own territory, hypothetical as it may be, might have undergone in the periods of 1933, 1934 or 1936, 3 mo. of dry weather when rainfall run-off would be by no means equal the evaporation in his little lake.

We point out that, under a condition of 3-mo. drought, the little lake would have to produce 360 a. in. after evaporation, seepage and other losses. In so many words, we point out that there certainly would be stupidity of the rankest type on the part of your Mr. Fritz, the institution manager, and Joe, unless a study of the drainage area was made to determine the rainfall run-off characteristics and potential supply of the pond in question.

Even as this is written, stories have appeared in the popular press of imminent failure of surface supplies of municipalities and others from Tulsa to New York City if more precipitation does not come. So, before we let the "Joes" and needy brothers-in-law select the sources of water supply let's get some competent advice before too much stupidity is shown, hypothetically, editorially, or otherwise.

I think you have a fine magazine, Mr. Editor. If, however, it becomes necessary to refer to persons or things in a somewhat controversial light wouldn't it be sporting to give all the facts and the complete names?

HERBERT D. FRITZ
Maintenance Engineer
Independent School District,
Burlington, Iowa

This Made Our Hero Squawk Like Donald Duck

OF COURSE, if our Hero is as versatile as he is reputed, then his versatility should extend a bit further and include the art of persuasion in regards to the management. If this is true I would suggest that he also try to induce the management to purchase some type of combustion control for his boilers.*

With the combustion control in perfect operation (see POWER PLANT ENGINEERING advertisement section for details) he would then have the time to work out the solutions to his own problems and not have to bother us engineers who only try to solve these problems to be of help to some dear brother engineer in distress and not to satisfy our ego or to try and collect the fifteen bucks first prize. Excelsior!

G. L. RADAMAKER.
Chicago, Ill.

*Editor's Note: This was Mr. Radamaker's comment at the end of his solution of Problem No. 8.

How Would You Do It?

Our Hero gets help in his problem of adding new a.c. generating capacity on top of his present well balanced d.c. and process steam load, three questionable 150 lb. boilers, three good engine generator sets and 10,000 lb. per hr. process steam load. The suggestions range from purchased power through Diesel engines to an 850 lb. steam plant.

PROBLEM 8
Turbine Capacity and Arrangement

PURCHASED POWER or Diesel engines fitted in well with Problem 8 and it is surprising that out of some 30 solutions, only three individuals gave them even passing consideration. Apparently utility power salesmen and Diesel engine salesmen either do not follow our Hero's adventures or they lack the milk of human kindness and leave him to struggle alone and unaided. His steam friends stuck by him loyally, however, and their advice ranges all the way from his present 150 lb. boilers to a new 850 lb., 825 deg. F. plant. From here it's only a step or two up to the 2400 lb. class in the exclusive company of Philip Sporn of the A. G. & E. and J. C. Hobbs of Diamond Alkali.

Considering the questionable character of the old boilers, most of the entrants felt these should be removed to give additional space, or if space was not a factor, retained for standby. Some, however, felt they should be reset and perhaps superheaters added, particularly those who had a strong feeling that 150 lb. pressure was the most desirable for this size plant, regardless of how the power problem was solved.

Practically all the possible combinations were presented and because of the duplication the basic layouts have been summarized in Figs. 1 to 6. All of these are based on retention of the engine generators in active service. Figures 1 to 4 are based on high or medium pressure, require new boilers, with the old boilers scrapped or retired to standby service as circumstances and space permit. Several solutions, based on Fig. 5, suggest 150 lb. steam pressure, some preferring all new boilers, some one new boiler and at least one suggesting resetting the old boilers and adding superheaters.

Out of the 30 solutions, however, eight were for discarding the old equipment, or if it was not in the way and space was plentiful, keeping it for standby. Due to the process load this means the use of an extraction turbine, all eight suggesting the basic arrangement shown by Fig. 6 with the old equipment eliminated. Provision for a.c. was made in different ways. Two suggested two 150 lb. turbines, one a.c. and one d.c. Two preferred medium pressure and motor generator sets for the d.c. The remaining four suggested pressures from 150 to 420 lb. with a single turbine driving both an a.c. and d.c. generator. Turbine sizes suggested ranged from 500 to 1000 kw.

This method of summarizing leaves much to be desired but the data included were so spotty and inconsistent as to be practically meaningless. The incomplete nature of the problem analysis is due no doubt to the limit of 1000 words, while the conflicting data is probably due to hasty estimates or differences in the various assumptions which had to be made.

Figure 1, a simple superposed installation is probably the simplest in theory. However, to give the necessary a.c. output without disturbing the present d.c., process steam balance, it is necessary to go to very high pressures, a course which most felt was unjustified in a plant of this size, both from a cost and operating standpoint. Figure 2 is a slight improvement from the standpoint of flexibility but still involves either high pressure or wasted steam. The condenser in Fig. 3 will at a cost of from $8000 to $10,000 remove the bugaboo of wasted steam from the a.c. machine while the addition of a 5 lb. extraction point as in Fig. 4 makes it unnecessary to supply any process steam through a reducing valve. Using the turbine in Fig. 4, either an extraction or mixed pressure unit, gives complete flexibility.

By going to straight condensing, as in Fig. 5, or extraction condensing as in Fig. 6, it is practical to use low pressure, and either reset the old boilers to carry the total load or

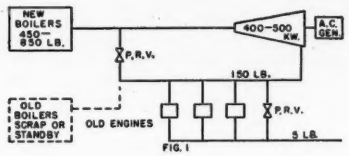


FIG. 1

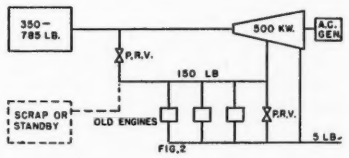


FIG. 2

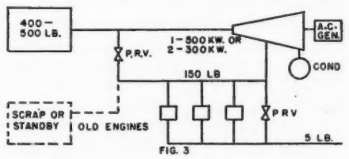


FIG. 3

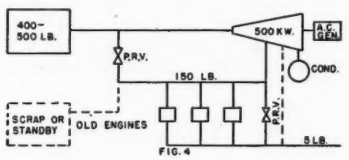


FIG. 4

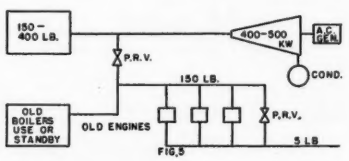


FIG. 5

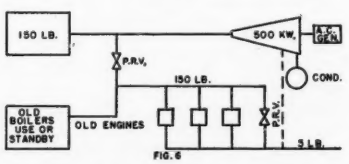


FIG. 6

perhaps add a new 150 lb. boiler. The majority who favored this arrangement preferred 150 lb. although several considered the economy of medium pressures justified even though the engines had to be supplied through a reducing valve and desuperheater.

While the judges do not concur in Mr. Maddock's final solution, nor the validity of his data for industrial conditions, he was awarded first prize on his: method of approach; consideration of the different possibilities; appreciation of fuel cost and hours of operation; and heat balance deliberations.

FIRST PRIZE AWARD

By Bill Maddock

Tucson, Ariz.

IN ORDER to make the comparison of installation costs more simple the costs per kilowatt hour were figured only as a function of the new equipment, with no attempt made to estimate the cost per kilowatt hour of the present plant. Inasmuch as nothing was asked about prime movers other than steam, the writer concluded that Diesels and gas engines were not to be considered, but a comparison was made anyway.

PROPOSITION No. 1

It is proposed to repair the present steam generating equipment to dependable condition, and to add three 200 kw. Diesel units to generate the required a.c. load. The following table holds for all the proposals and will not be carried forward:

	D.C.	A.C.	STEAM
Cap. Req'd., Kw.	350	450	10,000
Cap. Inst., Kw.	350	...	10,000
Cap. Needed, kw.	.....	450	.....
Aver. Load, kw.	220	380	10,000
Est. Kw-hr. per yr. × 1000	700	1200	.....

Costs

Repair of old boilers	$ 8,000
Three 200 kw. Diesels at $90 per kw.	54,000
Total investment	62,000

Unit Costs per Kw-hr.

Capital at 10 per cent	$0.00518
Fuel at 4 ct. per gal.	0.004
Labor	0.004
	0.01318

PROPOSITION No. 2

It is proposed to add two new high pressure boilers of 200 b.hp. each, 850 psi., 825 deg. F., capable of being fired at least 200 per cent rating. Also to install one 500 kw. turbine generator exhausting into the 150 psi. header. (Fig. 1.)

Costs

Boiler and superheater complete at ($80 per b.hp.)	$32,000
Turbo-gen. complete at $50 per kw.	25,000
Total investment	57,000

Unit Costs per Kw-hr.

Capital at 10 per cent	$0.00475
Fuel at 15 ct. per mil. B.t.u.	0.00120
Labor	0.004
	0 00995

PROPOSITION No. 3

It is proposed to install two new medium pressure boilers, 200 b.hp., 450 psi., 700 deg. F., and a 500 kw. combination bleeder and condensing turbine. The turbine to bleed at 150 psi. to the low pressure header. (Fig. 3.)

Costs

Boiler, valves, etc., complete.	$28,000
Turbine	25,000
Condenser	4,000
Total Investment	57,000

Unit Costs per Kw-hr.

Capital at 10 per cent	$0.00475
Fuel at 15 ct. per mil. B.t.u.	0.00150
Labor	0.004
	0.01025

PROPOSITION No. 4

It is proposed to repair the present boilers, install one new 400 psi., 700 deg. F., 200 b.hp. boiler, also a straight condensing 500 kw. turbine. (Fig. 5.)

Costs

Repair	$ 8,000
New boiler	14,000
Turbine	25,000
Condenser	4,000
Total Investment	51,000

Unit Costs per Kw-hr.

Capital at 10 per cent	$0.00433
Fuel at 15 ct. per mil. B.t.u.	0.00325
Labor	0.004
	0.01158

Of the four proposals calling No. 2 seems the most economical. For the purpose of showing the operation that could be expected, the heat balance, schematic diagram (Fig. 2), a short explanation of this proposal is included.

Heat balance calculations indicate a throttle flow of over 11,000 lb. of steam per hr. Should all of the demands peak together there would be a slight excess that would have to be discharged or taken up in the process of feedwater heating requirements. Also a slight variation in the turbine exhaust pressure could be made so no steam would have to be lost to the atmosphere. Supposing that the a.c. had a peak of 450 kw. and the d.c. was 180 kw. with a 10,000 lb. steam demand. All that would be necessary would be to by-pass the d.c. machines direct to the process.

If the a.c. load was up and the steam and d.c. were down then a change in the exhaust pressure of the turbine would take care of the balance. A change of 50 psi. in the exhaust gives about 10 per cent more kw. for the same steam flow and gives about a 20 per cent decrease in the amount of d.c.

Of course if the steam and d.c. load were high with a light a.c. load, the extra steam would have to come through the reducer and de-superheater to the low pressure header or the exhaust pressure of the turbine might be raised if the engines could stand the extra pressure and temperature. This gives the most flexible operation of any of the four methods with the possible exception of the Diesel units. The operation is relatively simple but calls for rather expensive controls and equipment.

But $57,000 is a lot of money even if the return is good and maybe the future outlook will not stand such a high investment. In fact in all probability it will be more economical in the long run to add low pressure boiler capacity and use a small straight condensing turbine or uniflow engines on the a.c. power.

If space is at all limited, surely the Diesel units or gas engines must be considered. This is especially true if there is any chance of using the waste heat any place in the plant. With suitable heat reclaiming equipment the heat rate chargeable to the a.c. may be as low as 6000 B.t.u. If from Proposition No. 1 the fuel cost could be cut in half, the costs per unit would be comparable to other set ups. There is a chance that the low Diesel standby charges may make the internal combustion engine the best answer to this problem.

A New $25 Prize Contest—No Problem This Month

Our Hero tapped the Boss for a vacation and will spend a month in a nice quiet insane asylum so Problem 10 will be held over until the May issue. In the interval there is a new contest—an easy one in which everyone can operate. A prize of $25 will be given for the best letter received during April. This may be humorous or serious on any phase of power engineering—how you came to be an engineer, why you do or do not like it, how you did some job to improve operation, increase efficiency or reduce cost, personal problems, organization, records, some incident you remember, etc. There are only a few rules. Letters must not exceed 1500 words but may be supplemented by drawings or photographs if you wish. Any reader may submit one or more entries but they must be in our office on or before April 30. There will be one prize of $25 but duplicate prizes will be awarded in case of a tie. The editors will serve as judges and their decision will be final. All letters will become the property of Power Plant Engineering, subject to publication in the magazine. All material published (except the prize winning letter) will be paid for at regular rates. This contest is easy—the words are all in the dictionary, all you have to do is pick out some good ones and put them together in the right way. Be sure and mark your entry "April Prize Contest."

SECOND PRIZE AWARD

By Percy S. Austen
Sewaren, N. J.

IT BEING an industrial power plant the management probably looks on it as a necessary evil on which money can be wasted all too easily, but devoid of such opportunities for attractive investment as is possessed by the so-called productive departments. This being the case, our Hero had better get up some pretty convincing arguments when it comes to recommendations for making investments in new power equipment that entail the replacement of equipment in operating condition, or he may wind up behind the eight ball.

In the article "Economics of High Pressure Steam," POWER PLANT ENGINEERING, April 1939, are curves showing that the smaller the capacity of the

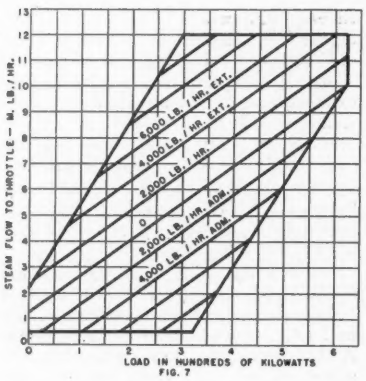


FIG. 7

power plant, the lower the maximum steam pressure that economically can be justified. Consideration of the trend indicated by these curves, together with the increasing difficulty of adequately handling feedwater treatment the higher the pressure in a small plant having a high percentage of make-up, and the expense of replacement of some of the piping and auxiliary equipment that would be required by a higher pressure, lead to the conclusion that 150 lb. ga. is best in this particular case. The d.c. engine-generators should be retained and operated as at present to carry the d.c. load.

If the d.c. and a.c. peaks occur at the same time then the peak a.c. load will be 725 — 275 = 450 kw., with an average of 600 — 220 = 380 kw. In order to provide a spare, two 500 kw. a.c. turbo-generators should be installed, operating condensing, with provision for automatic extraction and mixed pressure operation at 5 lb. ga. (Fig. 6) Let the throttle pressure be 150 lb. ga. with 70 deg. superheat so that the present steam lines may be utilized, as they may have cast iron fittings not recommended for use at over 450 deg. F. total temperature. Since ample condensing water is available, the condenser should be large enough to give not less than 28½ in. vacuum under average conditions as it does not take much increase in vacuum to be equivalent to a considerable increase in throttle pressure. The approximate performance curves for such a machine are given in Fig. 7.*

The engines have probably been operating on saturated steam, but a total steam temperature of not over 450 deg. F. should not cause trouble from the valves sticking or warping Depending on whether the engines are simple or compound and on how the units are loaded, the combined steam rate of the engine-generator units probably will vary between 37 and 47 lb. per kw-hr. with the superheated steam. For the sake of simplicity assume 42 lb. per kw-hr., then the exhaust steam from the engines will vary between 42 × 275 = 11,550 and, say, 42 × 180 = 7,560 lb. per hr.

In the interest of cycle efficiency, elimination of oxygen from the feedwater, and to minimize any possibility of unequal strains in the boiler due to cold feedwater, the changed layout should include a direct contact feedwater heater in which the feedwater can be heated to about 225 deg. F. Let it be assumed that the boiler feed pump and other non-condensing auxiliaries require 15 per cent (5 to 6 per cent for a feed pump and 9 to 10 per cent for a forced draft fan are reasonable figures for this case) of the total steam produced, which will furnish about the amount of exhaust steam needed to heat the feedwater from 65 to 225 deg. F., making allowance for heat lost in blowdown. Assume that a.c. electrically driven auxiliaries require 30 kw.

With a d.c. load of 275 kw., an a.c. load of 450 + 30 kw. and 10,000 lb. per hour of process steam, the maximum boiler load will consist of 11,550 lb. per hr. to the engine-generator units, 7,210 lb. per hr. throttle steam to the turbo-generator (11,550 — 10,000 = 1,550 lb. per hr. mixed pressure steam to the turbo-generator in addition to the throttle steam), and auxiliary steam of (11,550 + 7,210) × 15/85 = 3,310 lb. per hr. or a total of 22,070 lb. per hr. at 150 lb. ga. With a factor of evaporation of nearly 1.08 or 32 lb. per b.hp. the maximum boiler load will be 22,070/32 = 690 hp.

Since a 350 hp. boiler with adequate firing equipment, furnace volume and draft should be good for 200 per cent or more of rating, or at least 700 b. hp., it would appear as though there are three courses open as regards the boilers:

1. Installation of superheaters in the old boilers, two of which should be able to carry the load even if the draft is poor, with the third as a spare.

2. Scrapping of one boiler, which would make available additional space, and replacement and modification of as much as necessary of firing equipment, setting, and draft equipment to enable each of the other two boilers to operate at 200 per cent of rating, provided of course that the boiler drums are in good condition and do not have lap joints for the longitudinal seams which are anathema to insurance companies.

3. Installation of one new boiler and retention of two old boilers as standby units.

The third course would probably be the most economical in the long run and be followed by the installation of a second unit and scrapping of the two old standby units, but there might be reasons why the management would prefer the first or second course.

Although the actual steam quantities may be somewhat different from the approximations arrived at in the above discussion, it is evident that the machine recommended is sufficiently flexible to fit quite a range of conditions and meet considerable change in electrical or process steam load in an economical manner.

SECOND PRIZE DUPLICATE AWARD

By T. Holtz
Pottstown, Pa.

IF OUR HERO is wise, he will save himself many headaches, and his company some money, if he will prevail upon his management to purchase power from the local utility company for the a.c. motors installed to drive the equipment in the proposed factory addition. The conditions outlined bring to the fore very prominently the ever-recurring question of whether an industrial concern shall produce its own power or purchase from the central station. When all circumstances are properly balanced it will be generally admitted that the only case in which the industrial plant is justified in competing with the central station is that in which the plant can use the steam exhausted from the prime movers, in some manufacturing process.

Thus our Hero's company in its present situation has the most efficient possible installation. However, since the proposed expansion does not include additional exhaust steam requirements the production of the additional power must stand on its own feet and in the small quantities involved and small generating units that must be considered, it is impossible for the industrial power plant to compete with the central station, in cost of power or, unless excess equipment be installed, in reliability of service.

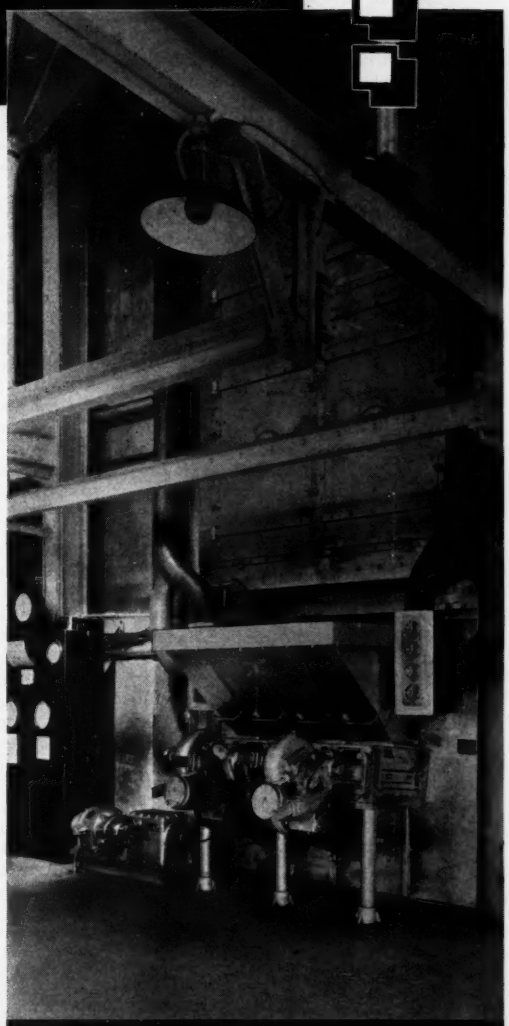
The plan suggested in our opening paragraph has several advantages in addition to the saving in cost of power and reliability of service. It reduces materially the investment which the company must make at once to provide the expansion, while requiring no backward step in case the company should decide later, when replacing the boilers, which are now approaching the end of their useful service, to provide sufficient power load. Since it is desired to retain the present d.c. motors and the d.c. generating units are in good condition, it would then be necessary to consider only the a.c. generating units and accessories, if, as, and when, it should be determined that home production of the entire power needs is desirable. Detail figures to support these assertions involve so many assumptions as to operating conditions, nature of load, hours of service, etc., that only generalities can be given here.

If the conditions stated should become the basis of an order to our Hero, to proceed with the installation of the necessary equipment he will need a 400 kw. turbo-generator unit with condenser, exciter and switchboard, and for boiler equipment three 300 hp., 150 lb. ga. boilers, with necessary stokers, feed pump and, unless the original builders were unnecessarily generous, additional smoke stack. The fact that the present d.c. engine driven equipment is in good condition limits the working steam pressure to its present figure. The three boilers will provide a spare for maintenance, and if the matter of reliability of service is of sufficient import, it will be necessary to duplicate the generator unit.

This minimum of equipment will cost approximately $75,000 and the best cost of power, for fuel only, will be about 0.75 ct. per kw-hr. If the plant operates on a single shift 40 hr.

*An article explaining the method of calculating these curves appears on page 77 of this issue.

How good should you expect "Feedwater Treating Service" to be?



RESULTS obtained with the feedwater treatment being used in your plant will vary with the condition of your boilers . . . the raw water supply . . . the operating rate, etc. Nevertheless, we believe you are entitled to know whether results you are obtaining are as good as should be expected.

One of the best ways to answer this question is to know about the results being obtained in other plants. Following are a few recent reports on plants served by Nalco:

NO SCALE— "They use 100% make-up of a 17 grain Lake Michigan water and operate 8 months between washouts. Boiler can be washed down to the metal. Whereas, before, heater scaled up so badly it could not be operated over one month, they now inspect it once a year and find only a very small amount of soft slush."

CUTS COSTS— "Mr. ——— is very well pleased with the job Nalco has done in this plant. He figures that he is saving at least $196.00 per three months per boiler, estimating fuel savings, labor savings, and reduced cost of chemical treatment."

NO TURBINING—"They have run 2 years without turbining their boilers. Their make-up is 100%. Their feed-lines and heater are absolutely clean. Their boilers, recently opened for inspection, were put back on the line immediately and without any cleaning except a quick wash."

ON LINE 18 MONTHS— "Yesterday the No. 4 boiler was inspected for the first time after 18 months continuous operation and was found in such good condition that it was placed back on the line, immediately. Even the lower row of tubes, which usually give evidence of a slight scale formation, were perfectly clean."

NALCO offers complete water treating service for power and process plants. Adoption of the Nalco System requires no additional capital investment. Total cost may be less than your present expenditures for chemicals alone. Write for complete information. NATIONAL ALUMINATE CORPORATION, 6224 W. 66th Place, Chicago, Illinois.

THE Nalco SYSTEM OF FEEDWATER TREATMENT

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per wk., the power required will be about 70,000 kw-hr. per mo., which, at the rates prevailing in this district, will cost 1.67 ct. per kw-hr., if purchased from the public utility company.

Thus the difference between purchased power and fuel only for the private plant figures less than $6,000 per yr., which must cover attendance, maintenance of equipment, depreciation and interest on the investment. Considering that no allowance has been made for additional smoke stack or for any additional floor space for the proposed equipment, depending upon the generous design of the present plant, it will be seen that from a purely financial standpoint the recommendation in our opening paragraph is well founded.

THIRD PRIZE AWARD

By Alfred W. Broadhead

West Allis, Wis.

THERE ARE three plans I'd like to offer our Hero for the solution of Problem 8, turbine capacity and arrangement. The first is the least flexible of the three and requires a balance of steam conditions, load, and process steam.

If the engines don't have condensers this plan is already eliminated because there would be an excess of exhaust steam. The new equipment required is a non-condensing automatic extraction 500 kw. a.c. turbo-alternator designed for steam conditions of 350 lb. ga., 525 deg. F., 5 lb. ga. with the automatic extraction at 150 lb. ga. (Fig. 2.)

The cost of this unit delivered and erected is $29,600. The average load of 220 kw. d.c. taken on the engines would require an extraction from the turbine of 5500 lb. per hr. Taking into account the work done by the bled steam for the engines the average a.c. load of 380 kw. would require an additional 11,500 lb. per hr. of steam. This brings the total steam to the throttle up to 17,000 lb. per hr.

The steam to the engines would have a 50 deg. F. superheat and the exhaust from the turbine would have an entholpy of 1100 B.t.u. per lb. with 6 per cent moisture.

Plan No. 2 calls for a 500 kw. a.c. condensing automatic extraction turbo-alternator designed for steam conditions of 150 lb. ga., saturated, 28 in. vacuum with automatic extraction at 5 lb. ga. to supplement the engine exhaust whenever necessary. (Fig. 6.)

This unit costs $32,000 delivered and erected plus $8,000 for a condenser and auxiliaries. With this arrangement there may be an excess of 5 lb. ga. steam unless it is possible to operate an engine condensing, but it would never be necessary to put any steam through a reducing valve. The average electrical load plus 11,500 lb. per hr. of 5 lb. ga. process steam would require a boiler steam flow of 16,500 lb. per hr.

Plan No. 3 eliminates the engines by the use of a 750 kw. condensing, 3600 r.p.m. automatic extraction turbine driving, through a reduction gear, both a 500 kw. alternator and a 300 kw. d.c. generator at 900 r.p.m. This unit costs $38,400 delivered and erected plus $10,000 for a condenser and auxiliaries.

The turbine should be designed for steam conditions of 400 lb. ga., 600 deg. F., 28 in. vacuum with the automatic extraction point at 5 lb. ga. if our Hero wishes the greatest economy and expects any future increase in load.

These steam conditions will allow an extraction of up to 15,000 lb. per hr. at the average load anticipated. If the process steam load is expected to increase but not the electrical load, steam conditions of 200 lb. ga., 570 deg. F., 28 in. vacuum would allow greater extraction at low loads. The average electrical load plus 11,500 lb. per hr. of 5 lb. ga. process steam requires a boiler steam flow of 12,800 lb. per hr.

Since new boilers will be required no matter which plan is used and since their costs won't vary greatly for the steam conditions used, they are left out of the comparison.

Plan No. 1 requires the least outlay of capital, however it is also the least efficient and least flexible of operation. Plan No. 2 costs more but has the advantage of more economical operation and a greater flexibility. Plan No. 3 costs the most, is the most economical to operate and has the greatest flexibility. It should also prove to be the most economical plan in the long run. Plans 1 and 2 are makeshift arrangements and complicated in comparison with the simplicity and ease of operation of Plan No. 3.

Since I don't know all the conditions I'll leave it up to our Hero to weigh the pros and cons of the three plans. The estimated accuracy of the figures used is 5 per cent.

GENERAL COMMENT

Apparently industrial managements are tough for G. L. Radamaker of Chicago, Ill., seems to see eye to eye with Mr. Austin, with the well known eight ball as "something not well to be behind." He says: ". . . . economy in the selection of machinery and especially in first cost is of prime importance . . .

"In the first place, I don't doubt that our Hero would rather chuck the reciprocating engine units out in the alley and replace with a nice shiny new condensing extraction turbine, but since the reciprocating engine units are supposed to be in good condition he might have a very embarrassing time trying to convince the management that this would be the best solution . . .

C. E. Olive of Drummondville, P. Q., is also insistent on the matter of costs and the importance of certain missing data. A portion of his solution follows: ". . . three factors, all of which have quite an important bearing on the case are: The number of hours a week that the plant runs; the nearness or otherwise of good coal; and the space available for additional plant, without having to extend the building."

While seeing the practical advantage of a 500 kw. condensing turbine operating from the existing boilers, S. Langer of Wood River, Ill., is intrigued by the fuel economy of an 800 lb., 500 kw. unit exhausting at 5 lb. and bleeding at 150 lb. He says: "During average conditions the system would be well balanced with steam generation of 11,840 per hr. at 785 psi. ga. and 725 deg. F. There would be 10,000 lb. per hr. extracted at 150 psi. ga. which would be used through the present power generating units. The remaining 1840 lb. per hr. would exhaust from the turbine at 5 psi. ga. with sufficient heat remaining to produce 226 deg. F. feedwater."

While offering several possible solutions with an eye on reliability Leslie Bradley of Bismarck, N. D., would like to abandon the present prime movers with an eye to reducing first cost and gaining more room: ". . . . by discarding the present prime movers and installing turbines there would not be any need of providing for more steaming capacity, for the present boilers should be more than adequate. By removing the prime movers he now has he would provide the room necessary for the turbine or turbines whichever plan our Hero decides on."

Alf Hansin of Denver, Colo., figures that a 400 lb., 700 deg. F., 750 kw. condensing unit and a 300 kw. m.g. set will save 8.7 per cent in fuel over a low pressure condensing unit and the present engines but does not consider it advisable to go beyond this pressure unless fuel is very expensive. He is also one of the very few considering the problem in relation to possible future expansion of the company, for "It is also important to know if this is the first step in a more far reaching expansion program or if further expansion is not expected."

Among those favoring a 450 lb., 750 deg. F. condensing unit with 150 lb. extraction is Henry E. Zeffren of St. Louis, Mo. In connection with emergency operation he says, "In the event that the extraction turbine is out of service for any reason, steam pressure reducing valve should be purchased to permit bypassing the turbine to feed the 150 lb. header. Desuperheating will be necessary at the outlet of this valve also. Considering the reliability of turbine units, if utility standby is available, one turbine of 500 kw. capacity should be purchased to carry the entire a.c. load. If standby is not available, two units of 300 kw. each should be purchased."

Jesse L. Erisman of St. Louis, Mo., would keep the old engines, replace one of the boilers with a 15,000 lb. per hr., 450 lb., 675 deg. F. boiler and a double extraction condensing turbine. He would keep the remaining two boilers for standby but "the new boiler and turbine generator can operate for a long period with only periodic inspection during the production schedule. Thus I have not provided any standby for the new equipment, thereby lowering first cost and overhead. I would recommend also that the generator be designed for 440 v., 3 ph., 60 cycle, thereby saving the cost of transformers and transformer operating losses."

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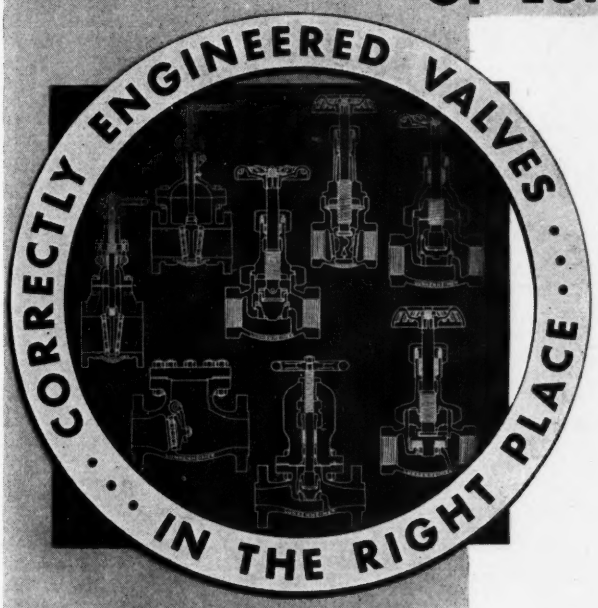

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If you compare invoice prices on valves of similar type and service requirements, you would be led to believe that all are the same "quality," because they vary but little in initial cost. It is obvious, therefore, that some other basis of comparison should be found in order to get a true picture of relative valve values. Lunkenheimer, during subsequent months, will focus attention on the engineered qualifications of its different types of valves which give them greater inherent ability not only to provide a better all-over performance, but to do so at substantial savings in needless servicing and maintenance expense.

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We cordially invite you, therefore, to follow this new series of factual advertisements and urge that, at your first opportunity, you ask our distributor in your area to take a Lunkenheimer valve apart and let you actually see the proof of Lunkenheimer's greater potential economy.

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PERCENT OIL LOSS CHART

STACK-TEMPERATURE ° FAHR.

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CO_2 %	Excess Air	900	850	800	750	700	650	600	550	500	450	400
15.3	0	15.4%	14.5%	13.7%	13.0%	12.1%	11.3%	10.5%	9.7%	8.8%	8.1%	7.2%
14.6	5	16.0	15.1	14.3	13.5	12.6	11.7	10.9	10.1	9.2	8.4	7.6
14.0	9	16.7	15.9	15.0	14.1	13.2	12.4	11.4	10.5	9.7	9.0	7.8
13.4	14	17.6	17.1	16.1	14.7	13.8	12.9	11.9	11.0	10.0	9.1	8.2
12.8	19	18.3	17.4	16.3	15.3	14.4	13.4	12.4	11.9	10.4	9.5	8.5
12.0	26	19.0	18.0	17.0	15.9	14.9	13.9	12.8	11.8	10.8	9.8	8.8
11.3	33	19.8	18.7	17.6	16.6	15.5	14.5	13.5	12.4	11.3	10.2	9.2
11.0	36	20.3	19.2	18.2	17.1	16.0	14.9	13.8	12.8	11.6	10.5	9.5
10.7	40	21.1	20.0	18 9	17.6	16.5	15.4	14.2	13.2	12.0	10.9	9.8
10.5	42	21.7	20.6	19.4	18.3	17.1	15.9	14.7	13.6	12.5	12.2	10.1
10.1	48	22.5	21.2	20.0	18.9	17.6	16.5	15.2	14.0	12.8	11.6	10.5
9.8	52	23.2	22.0	20.7	19.4	18.2	16.9	15.7	14.4	13.2	11.9	10.7
9.3	60	23.8	22.5	21.2	20.0	18.7	17.4	16.1	14.8	13.6	12.2	11.0
9.0	65	24.6	23.2	21.9	20.6	19.3	18.0	16.6	15.3	14.0	12.6	11.4
8.8	68	25.3	23.9	22.5	21.2	19.8	18.5	17.1	15.7	14.3	13.0	11.7
8.6	71	26.0	24.6	23.2	21.8	20.4	19.0	17.6	16.1	14.8	13.4	12.0
8.4	75	26.9	25.4	23.9	22.5	21.0	19.5	18.1	16.7	15.2	13.8	12.3
8.2	78	28.0	26.0	24.5	23.0	21.5	20.0	18.6	17.6	15.7	14.2	12.6
8.0	81	28.9	26.5	25.1	23.6	22.1	20.6	19.0	17.5	16.0	14.5	13.0
7.9	83	29.1	27.3	25.8	24.2	22.6	21.1	19.5	18.0	16.5	14.9	13.3
7.7	88	31.1	28.7	27.1	25.4	23.8	22.2	20.5	18.8	17.2	15.6	13.9
7.6	91	32.5	30.0	28.3	26.6	24.9	23.2	21.4	19.7	18.1	16.3	14.5
7.3	93	34.0	31.3	29.5	27.7	26.0	24.2	22.3	20.6	18.8	17.1	15.2
7.1	99	34.6	32.0	30.2	28.5	26.6	24.7	22.9	21.0	19.2	17.4	15.6
6.9	102	35.4	32.2	30.7	29.0	27.1	25.2	23.3	21.4	19.6	17.7	15.8
6.6	116	36.1	32.9	31.9	29.5	27.6	25.7	23.7	21.8	20.0	18.0	16.2
6.4	124	36.8	34.1	32.1	30.2	28.2	26.2	24.3	22.3	20.4	18.5	16.5
6.2	135	37.5	34.7	32.7	30.7	28.7	26.7	24.7	22.7	20.7	18.7	17.7
5.9	150	38.3	35.4	33.4	31.3	29.7	27.2	25.2	23.2	21.2	19.2	17.2
5.7	160	38.9	36.1	34.0	32.0	29.9	27.7	25.7	23.5	21.5	19.4	17.4
5.5	172	39.7	36.8	34.7	32.5	30.4	28.2	26.2	24.0	21.9	19.7	17.7
5.3	183	40.5	37.6	35.4	33.2	31.0	28.8	26.2	24.5	22.3	20.2	18.0
5.1	190	41.5	38.3	36.0	33.9	31.1	29.3	27.2	24.9	22.7	20.5	18.3
4.9	200	42.2	39.1	36.8	34.5	32.3	29.9	27.7	25.4	23.2	20.9	18.7
4.7	212	43.0	39.8	37.5	35.2	32.8	30.5	28.2	25.9	23.6	21.2	19.0
4.5	225	43.7	40.6	38.1	35.8	33.5	31.0	28.7	26.4	24.0	21.6	19.2
4.3	244	44.0	41.3	38.8	36.0	34.0	31.5	29.2	26.7	24.3	21.9	19.5
4.1	263	45.4	42.1	39.1	37.2	34.6	32.0	29.7	27.2	24.7	22.3	19.8
3.9	280	46.2	42.9	40.3	37.9	35.4	32.7	30.2	27.8	25.8	22.7	20.2

EXAMPLE: Stack temperature 650 deg. F. and CO 9.0 per cent. From the chart the excess air is 65 per cent and the oil loss, 18 per cent.

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WHEN Commodore Perry landed with his prisoners after his victorious battle at Put-in-Bay in mid September 1813, one of the many who watched the march of the victors and their prisoners up the banks of Lake Erie at the village of Erie, Pa., was a teamster, named Boyd Vincent, whose occupation at the time was trucking salt over the country roads from the salt works in central New York to Erie and other neighboring points of consumption. Just what thoughts were running through his mind as he watched the pompous spectacle in a frontier village, records do not reveal. At this time, or shortly afterwards, however, the ambition to establish an iron foundry in Erie became an aim in his life toward which he struggled many years to accomplish.

In the light of history one can readily point to many advantages for the location of such an industry at that location. Vincent as a teamster knew the extreme hardships and expense of freight transportation by animal power. With the British no longer controlling the Great Lakes water transportation, there was an open sea for the delivery of products to expanding industries in the great Northwest. Within easy reach of Erie were all the raw materials necessary for iron foundry operation—coal, iron, lumber, refractory clay, moulding sand, and now free water transportation to a vast undeveloped country much of which was still unexplored.

ERIE CITY IRON WORKS,
ERIE, PA.,
MANUFACTURERS OF
Portable and Stationary Engines
BOILERS AND CIRCULAR SAW MILLS.

Fig. 1. The portable boiler and engine unit was a popular prime mover for oil wells and saw mills

Steamships had scarcely reached the horizon of transportation facilities since Fulton's first successful trip up the Hudson in 1807, followed in 1811 by the first trip of a steamboat from Pittsburgh to New Orleans by way of the Ohio and Mississippi Rivers and it was not until 1818 that the first steamship appeared on Lake Erie. Here was a new industry

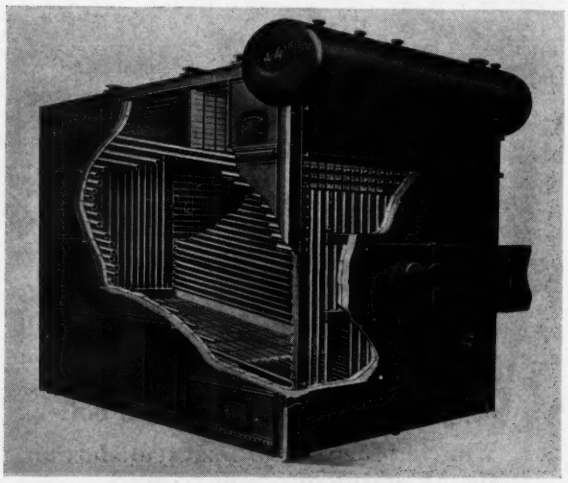
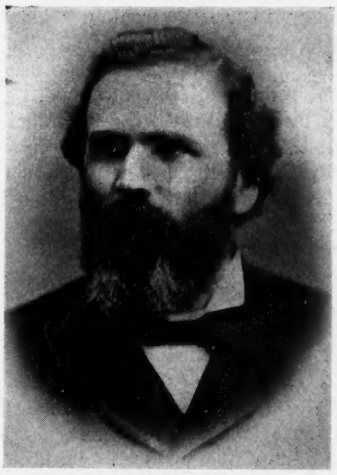


Fig. 2. An internally fired cross drum boiler typical of the trend of boiler design followed by Erie City Iron Works, today

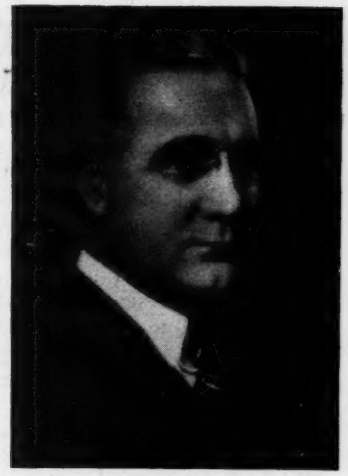
that would require the products of an iron foundry. Transportation of that day was the greatest deterrent to the development of the country. Neither the Erie nor the Welland Canals were anything more than proposed projects at the time of Perry's landing. Steam railroads started with the Baltimore and Ohio chartered in 1827 and first rails were laid in 1828.

So when Boyd Vincent conceived the need for an iron foundry in Erie, history certainly proves that his judgment was sound. It was not, however, until 1840, some 27 yr. later, that this particular ambition of his became a reality when he took active part in the establishment of the Presque Isle Foundry under the company name of Johnson & Himrod. In 1843, however, the firm name was changed to Vincent & Himrod Co. after a fire which called for reorganiza-



George Selden, President, 1863-1893

George D. Selden, President, 1897-1922



Hays H. Clemens, President since 1925

tion. This company confined its operations to the smelting of ore into iron and the making of castings for the needs of industry. This left room in the economic welfare of the community for a manufacturing establishment equipped to turn out finished products that could be used in the factories, mines, farms and homes, such as engines, boilers, pumps, tanks, and many other requirements of the industry of the day. To this need in 1851, the year in which Erie City was incorporated as a city, Selden and Bliss started a manufacturing establishment called the Erie City Iron Works, its location being at what is now 12th and State Streets, the heart of the business district of the city.

For some 12 yr. these concerns were closely associated and noncompetitive but Selden and Bliss had become more extensive and financially stronger until in 1863 a merger of interests took place, the business continuing under the firm name of the Erie City Iron Works. Thus this one-hundred-year-old establishment proudly traces its beginning to the Presque Isle Foundry which started operations in 1840 but was conceived a quarter century earlier when the Great Lakes were positively established as American water ways.

Since 1863 this company has continued under the management of the Selden family first as a partnership but was changed into a corporation in 1894. George Selden was president from 1863 to 1893, being succeeded four years later by a nephew, George D. Selden, who held the office until 1922 and since 1925 Hays H. Clemens, son-in-law of George D. Seldon, has held the office of president.

The expanding activities of this company and the rapidly increasing value of the real estate occupied by the plant in the center of the city's business district were factors which brought about the building of the present plant at 14th Street and East Ave. where its factory and offices are now located. This move took place over the five-year period from 1884 to '89 and provided the company with adequate room for expansion as well as railway facilities.

In the development of this industrial enterprise at least two men with outstanding characteristics played extremely important parts, these were Vincent and Selden.

Bethuel Boyd Vincent, the teamster who visualized the possibilities of an iron industry in Erie City, had the characteristic perseverance of the pioneer of his day. It took many years before he obtained the capital necessary to launch in the business he was sure would prosper and the activities of him and members of his family have had a beneficial influence in the life not only in this community but throughout the country. He was the father of General Strong Vincent, an uncle of Bishop John Heyl Vincent, founder of the Chautauqua, an uncle of the father of Henry B. Vincent, director of Erie's Playhouse, and of the mother of Raymond Massey who plays Lincoln in "Abe Lincoln in Illinois." He had the vision, foresight, perseverance and ability to start and conduct a business concern that has prospered for 100 yr.

It is to George Selden, however, who came into the business a little later than Vincent that the Erie City Iron Works owes the broad scope of its activities, the vigorous conduct of its affairs during a period when the industries of the middle west were suffering growing pains, the formulation of business policies many of which are found vital today, the lasting backlog of the financial strength of the company and the reputation for supplying products of the highest quality.

George Selden sought adventure as a youth. He shipped as a cabin boy on a clipper ship from New York to the East Indies and China. Later joined the forty-niners in the rush to California to pick the gold out of the hills. This experience brought him in contact with the Indians whose language he learned and whose hospitality and hardships he experienced for two years under the leadership of Chief Sitting Bull. Back in Erie City again, the iron industry gave him opportunities to develop latent talents, the benefits of which are still being felt in Erie. During his active years at the head of his company his horse and buggy were seen daily about the city and country, almost as a country doctor, on his errands of service to customers. Though not an engineer, he solved many problems requiring an understanding of scientific

principles by reason of his practical experience. One story is told of the erection of a steel water tower 237 ft. high that caused workmen considerable worry because they observed it was evidently tilted to one side. Shelden took an engineer and a transit to the scene one morning and, as reported, the standpipe was unquestionably leaning to the west. With the plea to let him think out what plan to follow, he left for his office and came back in the afternoon. When the transit was again put to work the standpipe was found to be tilting to the east. His explanation to the astonished workmen was that the bending of the standpipe was due to the heat of the sun expanding the side exposed to it more than the other side and so long as the tank was in balance it was perfectly safe.

Products of the company have naturally followed the needs of industry as developments took place over these one hundred years. During the forties pig iron and iron castings were about the only products supplied. In the fifties the demand was beginning to grow for factory machinery including boilers and engines. Then lumber mill machinery and equipment for coal and iron mining were being demanded by industry and the company equipped itself to provide these needs. At one time it was found necessary to maintain lumbering crews, coal and iron mining camps in order to provide the factory with the necessary raw materials. In those pioneer days the company found it necessary to design and build most of the machine tools used in the factory.

When oil was discovered in Pennsylvania near Pittsburgh in 1845 this company was in its infancy but by the time of the Civil War and for a generation to follow oil pumping was at its peak and Erie City Iron Works did an enormous business in supplying oil companies with practically all the oil pumping and handling equipment they required. The portable boiler and engine unit was popular in this field.

In the transition from the pioneering days when this company was called upon to manufacture nearly every kind of machinery needed by the growing country to the period of specialization as we find it today the Erie City Iron Works has directed its main efforts toward improving manufacturing methods in its plant rather than in searching for entirely new principles and developing products to meet them. As an example, the demands of the oil industry pointed to the need of having on hand at the factory a number of portable boilers that could be shipped on very short notice. Out of this grew the practice of building these units on a production basis and putting the surplus in stock for delivery on call. The practice having proved successful with portable units was later applied with entire success to return tubular and even water tube boilers.

In the early '80's the company developed a water tube boiler with cast-iron sinusoidal headers. This design, however, was soon succeeded by boilers of the steel boxheader type and it is only in recent years that the sinusoidal headers have been used in this company's standard designs, these, however, being made of steel instead of cast iron as in the early designs.

This company was the first, and only one so far as available records show, to use raw coal in a blast furnace for the smelting of iron ore. The reason for using this fuel was that for a short time coking coal was not available at the foundry.

Hydraulic riveters designed especially for fabricating boilers were first built and successfully used in this plant. Conforming with modern practice, welding methods and X-ray examination are employed in the plant of today.

Another first in the record of this company was the application of pulverized fuel to a horizontal return tubular boiler.

When asked for a simple set of rules which an industrial establishment might follow in the hope of being in business for one hundred years, G. D. Selden, Jr., Secretary and Sales Manager of the company replied, "Long experience has brought home many times to us the value of our firm policy of building to a high standard always. This coupled with our sincere desire to treat suppliers, customers and employees fairly, seem to me the essential qualities of every old well-established concern." In line with these rules, Erie City Iron Works has conducted its business without a funded debt of any character and its stocks have never been on the exchange market, its bills have always been discounted and its Dun and Bradstreet rating always the highest.

When the citizens of Erie publicly celebrate the one hundredth anniversary of its oldest industrial establishment, as is planned for next July, they will be paying tribute not solely to the individuals who have guided the affairs of the company but also to a long line of workers whose combined talents have been used to build the growing industries of the entire country during the past century.

George S. May, a Chicago business man, has announced plans for the organization of a foundation to do research work in the interests of private business enterprise.

The organization, to be known as the George S. May Business Foundation, has been granted a non-profit Illinois charter and will open offices at once in Chicago and New York. Research engineers will be maintained in eighteen leading American cities.

In explaining the purpose of the Foundation, Mr. May said:

"There is real need for a scientific, fact-finding study of the increasing problems which confront business management in its effort to earn profits under modern conditions. In the solution of these problems lies the fundamental solution to our national social problems, for our democratic institutions and our social welfare as a whole are dependent upon the success of business enterprise. We hope that our findings will serve in some degree not only as a direct aid to business men but as a constructive answer to the continual propaganda from sources opposed to the capitalistic system."

The Foundation, the announcement said, will be supported entirely by contributions from members of its Board of Trustees.

Hydrogen-Cooled Generators

ARRANGEMENTS for sealing the shaft used with General Electric hydrogen-cooled generators is illustrated in Fig. 1 and consists of a sealing ring attached to the generator side of each bearing, to which vacuum-treated lubricating oil is supplied under pressure. This creates a film of oil completely surrounding the shaft to effectually prevent the escape of hydrogen from the casing and the infiltration of air at this point. Since the sealing oil is vacuum treated to remove all absorbed gases, it will not give up air to the casing and reduce the machine hydrogen purity, nor, give up hydrogen to the bearing lubrication system.

Oil flowing away from the sealing rings is carried to treating tanks, the oil from the hydrogen side of the rings passing to a hydrogen-detraining tank and that from the air side passing to an air-detraining tank. In these tanks the larger bubbles of gas absorbed by the sealing oil while in contact with the hydrogen and air, separate out by gravity and are returned to the casing and to atmosphere, respectively. From these tanks the oil passes into a vacuum tank, where practically all of the gas remaining in solution is removed. The oil pressure at the seals is maintained at a few pounds per square inch higher than the hydrogen pressure in the casing by the operation of the seal oil pump and a pressure-regulating valve.

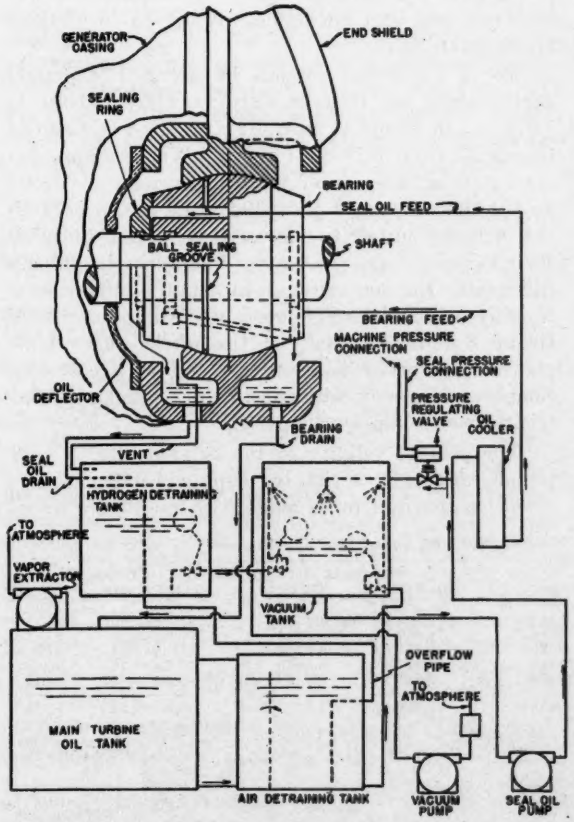


Fig. 1. Arrangement of the shaft sealing system for hydrogen cooled generators

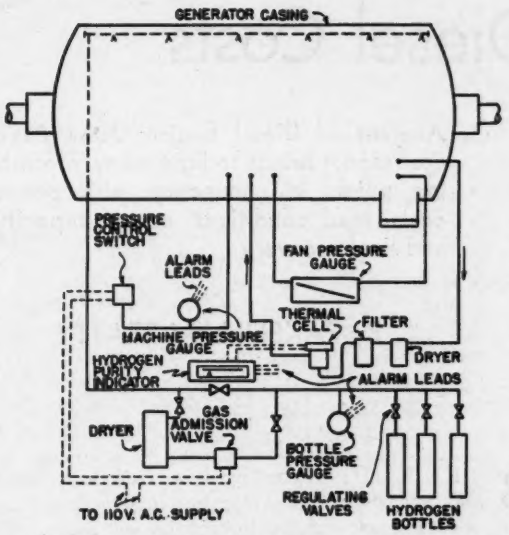


Fig. 2. Arrangement of hydrogen piping showing the method of charging the hydrogen, indicating the purity and maintaining the pressure inside the casing

To supply the hydrogen continuously required by the generator to compensate for the loss by absorption in the sealing oil and by leakage, the control system shown in Fig. 2 is employed. This arrangement includes a solenoid-operated valve controlled by a mercoid pressure-control switch which operates to maintain the hydrogen pressure in the generator casing between appproximately 8 and 12 in. of water, although some generators are designed for emergency operation at hydrogen pressures up to 15 lb. per sq. in.

This makes it possible to obtain increased output as a result of the improved cooling properties of hydrogen at the higher pressures and the considerably greater weight of hydrogen circulated. The hydrogent supply is contained in several commercial bottles, connected to a manifold. Pressure-regulating valves reduce the bottle pressure of approximately 2000 to about 20 lb. per sq. in. at the solenoid valve. The gauge for reading the reduced bottle pressure is provided with a contact, which operates an alarm to notify the operator when the connected bottle is nearly empty and ready to be replaced with a full one.

A continuous indication of the hydrogen purity in the generator casing is provided by a purity indicator operating on the thermal conductivity principle. Hydrogen from the generator casing is passed continuously through the analysis cell of the purity indicator by the action of the generator fans. A contact on the indicator operates an alarm if the purity reading falls below a predetermined value.

An independent indication of the machine hydrogen purity is provided by a gauge which indicates the pressure developed by the generator fans. This pressure is proportional to the gas density and therefore serves to indicate the hydrogen purity.

Diesel Costs

Analysis of Diesel Engine Users Ass'n cost report brings to light many interesting points in connection with power costs, load conditions, excess capacity and heat recovery

By PAKENHAM BEATTY

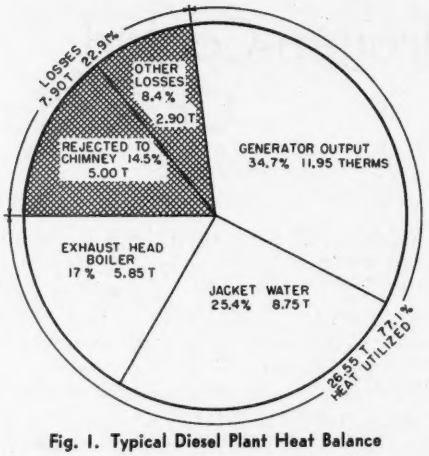

LOSSES 7.90 T 22.9%
OTHER LOSSES 8.4%
2.90 T
REJECTED TO CHIMNEY 14.5% 5.00 T
GENERATOR OUTPUT 34.7% 11.95 THERMS
EXHAUST HEAD BOILER 17% 5.85 T
JACKET WATER 25.4% 8.75 T
26.55 T 77.1% HEAT UTILIZED

Fig. 1. Typical Diesel Plant Heat Balance

BURKE SAID: "Economy is a distinctive virtue and consists not in saving but in selection," and this wise remark cannot lightly be set aside. The D. E. U. A. Working Costs Report for 1937-1938 affords remarkable testimony of the reduction in the cost[1] of electrical energy effected by the judicious choice of Diesel engine plants to meet a large range of operating conditions. The main statistical table may conveniently be divided into three groups:

Group 1. Public Generating Stations. 24 hr. service. 8 examples selected. Engines installed 49. Maximum demand 12,450 kw. Plant installed capacity 17,080 kw. or 137.2 per cent of maximum demand. Annual station load factor 1655 hr. or 18.9 per cent. Kilowatt hours generated 20.652 millions. Total works costs $217,719.12 or 1.056 ct. per U/G[2]. Fuel bill at $22.70 per ton[3], $127,445.76, or 0.6172 ct. per U/G. Wages at $110.00 per week, $45,836.00 or 0.2235 ct. per U/G. Repairs and maintenance equal to 1.67 per cent on estimated capital outlay, $26,741.50 or 0.1295 ct. per U/G. Fuel consumption 5645 t. or 0.612 lb. per U/G. Running plant load factor 66 per cent.

Group 2. Industrial Private Installations. Running 10 to 12 hr. a day. 8 examples scrutinized. Engines installed 41. Maximum demand 6925 kw. Plant installed capacity 9266 kw. or 133.6 per cent of the maximum demand. Annual station load factor, 1860 hr. or 21.25 per cent. Kilowatt hours generated 12.859 millions. Total works costs $132,-139.80 or 1.0276 ct. per U/G. Fuel bill at $23.77 per t., $82,522.44 or 0.6416 ct. per U/G. Wages at $64.11 per wk., $26,685.36 or 0.2077 ct. per U/G. Repairs and maintenance equal to 1.6 per cent on the estimated capital outlay, $13,852.80 or 0.10764 ct. per U/G. Fuel consumption 3470 t. or 0.612 lb. per U/G. Running plant load factor 66.6 per cent.

Group No. 3. Private Power Houses under Central Control: Running 14¾ to 17 hr. daily. 5 examples included. Engines installed 20. Maximum demand 4028 kw. Plant installed capacity 5780 kw. or 143.3 per cent of the maximum demand. Annual station load factor 4025 hr. or 46 per cent. Kilowatt hours generated, 16.202 millions. Total works costs $144,448.20 or 0.89115 ct. per U/G. Fuel bill at $21.34 per t., $92,734.20 or 0.5733 ct. per U/G. Wages at $104.36 per wk., $31,800.60 or 0.2067 ct. per U/G. Repairs and maintenance equal to 1.43 per cent on the estimated capital outlay, $7745.40 or 0.0507 ct. per U/G. Fuel consumption 4350 t. or 0.602 lb. per U/G. Running plant load factor 71 per cent.

[1] In converting pounds to dollars an exchange rate of $4.685 per pound was used (1 penny = 1.95 cts.)
[2] Units generated, i. e., kw-hr. generated
[3] Roughly 7½ ct. per gal.

In the light of this evidence, Table I was prepared. It is undeniably proved that averages, even true medial statements, can lead to dangerously false practical deductions, but in this instance it is felt the figures present a reasonable degree of uniformity and possess generally typical characteristics.

In the absence of detailed information, average capital expenditure of the order of $128.23, $125.19 and $134.41 per kw. of maximum demand has not unreasonably been taken. Writing off in 15 yr. with 5 per cent interest on the outstanding balance at the end of each year or, say, at the rate of 10 per cent per annum, has been assumed. No serious flaw will be introduced into the statements by reason of these approximations.

For a variety of reasons in Group 1, the total engine costs per U/G actually vary from 0.891 to 1.375 ct.; in Group 2, from 1.497 to 0.681 ct.; and in Group 3, from 0.78 to 1.074 ct. Wages (running) amount to an average of $110.00 per week in Group 1; $64.11 in Group 2 and $104.36 in Group 3. It is not, perhaps, unfair to suggest that those responsible for allocating wages in Group 2 have not included a full quota. Further criticism in detail is unnecessary. Notably and uniformly good operating results of Group 3 indicates that, on the whole, the private plants are worked with success and at a cost that compares favorably with the price of purchased electricity from a supply company.

The general validity of the two-part tariffs computed cannot be seriously disputed and enable a direct comparison to be made with public electricity

Table I. Approximate averages taken out on the basis of "Per 1000 kw. of Maximum Demand"

Item	Group 1 Total Costs Plant av.	Group 1 Ct. per U/G	Group 2 Total Costs Plant av.	Group 2 Ct. per U/G	Group 3 Total Costs Plant av.	Group 3 Ct. per U/G
Fuel	$10,225.80	0.61815	$11,934.00	0.6420	$23,049.00	0.573
Lubricating Oil	912.60	0.05460	1,057.68	0.0566	2,233.36	0.0566
Stores and Water, etc.	514.80	0.03020	248.04	0.01365	786.24	0.00195
Wages (Running)	3,683.16	0.21925	3,837.60	0.2069	7,895.16	0.2067
Repairs and Maintenance	2,138.76	0.12870	2,003.04	0.10725	1,918.80	0.0497
Total Engine Costs per U/G	17,475.12	1.05690	19,080.36	1.0257	35,882.56	0.8852
Two Part Tariffs Based on Above Data and per Kw. of Maximum Demand						
Proportion of Operating Expenses	$ 4.75		$ 4.84		$ 8.54	
Capital Charges	12.82		12.52		13.44	
Standing Charges	17.57		17.36		21.98	
Equivalent to, ct. per U/G	1.0608		0.933		0.554	
Running Charge, ct. per U/G	0.7664		0.767		0.67	
Total Cost, incl. 10 per cent on Capital Outlay, ct. per U/G	1.8272		1.700		1.2256	

Table II. An approximate heat balance of the three groups of plants shown by Table I

	Group 1		Group 2		Group 3		Total	
	Cost	M Therms	Cost	M Therms	Cost	M Therms	Cost	M Therms
Generator Output	$ 39,546.00	7.270	$25,566.84	4.455	$28,758.60	5.59	$93,871.44	17.315
Jacket Water	32,526.00	5.960	21,060.00	3.670	23,610.60	4.60	77,196.60	14.230
To Chimney	40,131.00	7.360	25,997.40	4.525	29,226.60	5.68	95,345.00	17.565
All other losses	15,242.76	2.800	9,898.20	1.725	11,138.40	2.16	36,279.36	6.685
TOTAL	$127,445.76	23.390	$82,522.44	14.375	$92,734.20	18.03	$302,692.40	55.795

supply tariffs. The widely differing amount of spare or reserve plant installed to meet exigencies and in response to a desire for safety is of great interest. The effect is reflected, of course, in the capital charges per kilowatt of maximum demand. The average overall thermal efficiency of the 21 plants, totaling 110 engines (of 32.124 kw. capacity; meeting a maximum demand of 23,404 kw.; generating, with an average running plant load factor of 67.5 per cent, nearly 49¾ million kw-hr., and consuming some 13,465 t. of fuel oil costing $302,702.40 per annum) may be put, as a maximum, at 31 per cent. This performance certainly leaves scope for improvement. An elementary global heat balance would read somewhat as in Table II.

Waste Heat

The diagram and figures, Fig. 1, put the matter quantitatively. Qualitatively it may be added that the circulating water enters the cylinder jackets at 140 and should leave at 160 deg. F. If the 43,750 lb. of circulating water per hour at 350 kw. load are passed through an exhaust heat boiler, its temperature may be raised to 173.3 deg. F.

Utilization of the heat in the jacket water and in the exhaust gases is not merely an inferior substitute for coal-fired heat. Allocating interest and depreciation at 10 per cent on the capital expenditure necessary to recover the waste heat and putting this at as high a sum as $46.85.00 per yr., the cost per therm is 0.936 ct. in the case of an engine working at 70 per cent of its rated load in a factory for 3430 hr. per annum.

If 42.4 per cent of the total fuel consumed as waste heat is allocated to heating at 0.975 ct. per lb. ($22.75 a ton, including tax) the fuel cost per therm is 5.265 ct. or, together with capital charges, 6.24 ct. per therm in all. This is lower than the relative cost of generating hot water in a coal or coke-fired independent boiler plant which generally works out to, say, fuel, 3.9 ct. plus capital charges, or 7.8 ct. to 8.775 ct. per therm. It is evident the cost of the necessary pump, valves, pipework, exhaust heat boiler, thermal storage tank, buildings, etc., for complete heat recovery is not then mere fruitless expenditure, difficult to justify. An exhaust heat boiler might well be, therefore, an integral and not merely an incidental feature of every Diesel engine.

Dr. Johnson once remarked "example is much more efficacious than precept" and a few additional figures relating to the Pinewood Film Studios may be of value. The problem of effective waste heat recovery has been solved at the studios by utilizing the heat in the jacket water and exhaust gases, of the 2500 kw. Diesel plant, in a hot water central heating system. Figures are given in Table III. The sum charged to Diesel heat for the relief of the electrical fuel bill of the studio load amounted to 31 per cent in 1937 and to 33.9 per cent of the studio fuel bill in 1938.

At these film studios the Diesel plant ran at 66.1 per cent thermal efficiency in 1937, contributing 35.75 per cent of the total heat required to warm the extensive buildings and to take care of the domestic hot water and canteen services. At 63.4 per cent thermal efficiency in 1938 it yielded 36.6 per cent of the total heat needed. Coal fired boilers produced 149,616 therms in 1937 at 8.7 ct. per therm (fuel 4.017 ct., 10 per cent interest and depreciation, 4.68 ct.) and 146,532 therms in 1938 at 9.555 ct. per therm.

If the heat from the jackets and exhaust gases of the Diesel engines, together with the electrical heat from the immersion heaters, used as load levelers for both the generators and the coal fired boilers, are all charged at these figures, i. e., at the cost of coal, the Diesel engines made a very substantial reduction to the oil fuel bill for studio electricity. The reduction in the fuel cost per U/G is from 0.66105 ct. to 0.45825 ct. in 1937 and from 0.772 to 0.5018 ct. per U/G in 1938. It is scarcely necessary to add that operating conditions at a film studio are not very kind to a Diesel plant, the annual station load factor being about 8.5 per cent and the running plant load factor about 50 per cent.

Heat recovery from such a thermally efficient machine as the modern four stroke cycle Diesel engine should not be restricted to the minimum necessary to produce electricity. The thermal effectiveness of the Diesel engine has a much larger range. It is apparent that the gain accruing from a full exploitation of the remediable wastage of heat in the jacket water and in the exhaust gases will contribute substantially to the reduction of working expenses.

Table III. Operating data on heat recovery at Pinewood Film Studios

	1937		1938	
Therms of Diesel heat, jacket, exhaust boiler and immersion heaters	83,180		84,603	
	Total	Ct. per Therm	Total	Ct. per Therm
Fuel corresponding to immersion heater load	$1,792.44	2.145	$2,143.44	2.535
10% Interest and Depreciation on Capital Outlay for waste heat recovery equipment, immersion heaters and their switchgear, etc.	2,574.00	3.090	2,574.00	3.042
Contribution towards reduction in fuel bill for Studio Demand for electricity, i. e., sum charged to Diesel heat to relief of electrical fuel bill for Studios	$4,366.44	5.235	$4,717.44	5.577
	2,878.20	3.461	3,369.60	3.980
	$7,244.64	8.696	$8,087.04	9.557

Phosphorized Admiralty CONDENSER TUBES

BY C. A. GLEASON

Engineer, Scoville Mfg. Co.

HISTORY JUSTIFIES the general recognition that Admiralty metal has excellent corrosion-resistance properties, but in certain conditions of operation and in certain localities Admiralty metal is subject to dezincification. One approach to this problem has been the use of red brass in oil refinery operations or arsenical copper in steam condensers. With sweet vapor or steam and fresh water excellent results have been obtained by this substitution. However, red brass and copper are unsuited to sour-vapor, salt or brackish water service and we find its use not satisfactory in those services.

Laboratory Tests

Long-time efforts to improve the resistance of Admiralty metal to dezincification have led us to add a small amount of phosphorus. Accelerated corrosion tests in our Laboratory indicate that at ordinary room temperatures the phosphorized Admiralty exhibits marked superiority over regular Admiralty. Also, at elevated temperatures, tests up to 120 deg. F. indicate that phosphorized Admiralty promises definitely-improved results. Temperature zones above 120 deg. F. have not as yet been explored in this connection in the laboratory, but field results indicate comparable results up to temperature limits for which Admiralty is adapted.

Curves of these test results for periods up to 60 wk. are shown by the drawing, with the explanation that specimens were totally immersed in 1 per cent cupric chloride solution and, at stated periods, tested for residual tensile strength and elongation. This has been found to be a more-accurate measure of the rate of corrosion than loss of weight determination or visual inspection or measurement of reduced dimensions.

Grain Size

Phosphorized Admiralty has been developed primarily for those places where the phenomenon of dezincification is pronounced, but, in addition that, the effect of phosphorus on other properties of the metal is beneficial. For example, the intrinsic hardness and strength of the alloy are increased. Phosphorus has a marked influence on the retardation of the softening and grain growth of the metal during heat treatment, and raises the initial softening temperature.

As an example of this effect, Admiralty metal without phosphorus, when annealed in the temperature range of 400 to 600 deg. C. would have a grain size of 0.02 to 0.06 mm. whereas with phosphorus the grain size is only 0.01 to 0.02 mm. over the same temperature range.

From this illustration, it is evident that the phosphorized Admiralty metal at any given annealing temperature would have a smaller grain size than regular Admiralty metal, and over any particular range of annealing temperature, the grain sizes would be more uniform. There are no structural changes in the alloy as a result of the addition of phosphorus other than the refinement of grain referred to above.

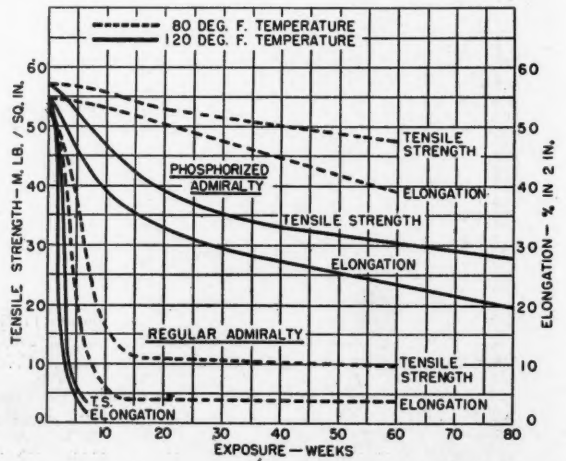
The following brief discussion is simple explanation of the way phosphorus acts as an inhibitor of dezincification.

Dezincification

Dezincification is an electro-chemical action in which certain areas of the metal surface become anodic to other areas and an electrolytic cell is set up in the presence of a conducting solution. Copper and zinc are dissolved at anodic areas and copper is redeposited at cathodic areas. As long as current is allowed to flow between anodic and cathodic areas, dezincification will proceed.

If, however, flow of current is prevented, dezincification will not occur. Phosphorus in Admiralty metal probably forms an insoluble, impervious film over anodic areas on the metal surface and thus prevents current flow and dezincification. The film, in all probability, is a corrosion product of the alloy containing phosphides, phosphates, or other phosphorus compounds.

As desirable as it is, the inhibition of dezincification would not in itself justify the addition of any substances to the alloy which would cause it to be any less serviceable from any other standpoint, but, as far as we know, and we have exploited the possibilities carefully and have accumulated an impressive experience table, the addition of phosphorus does not impair the ability of Admiralty metal to withstand general corrosion, nor does it affect adversely any of its properties. Phosphorized Admiralty may be expected to do as good a job as ordinary Admiralty in any circumstances, and certainly where there is the possibility of dezincification it will be decidedly superior.



Result of corrosion tests with the test specimens totally immersed in a one per cent solution of cupric chloride ($CuCl_2$)

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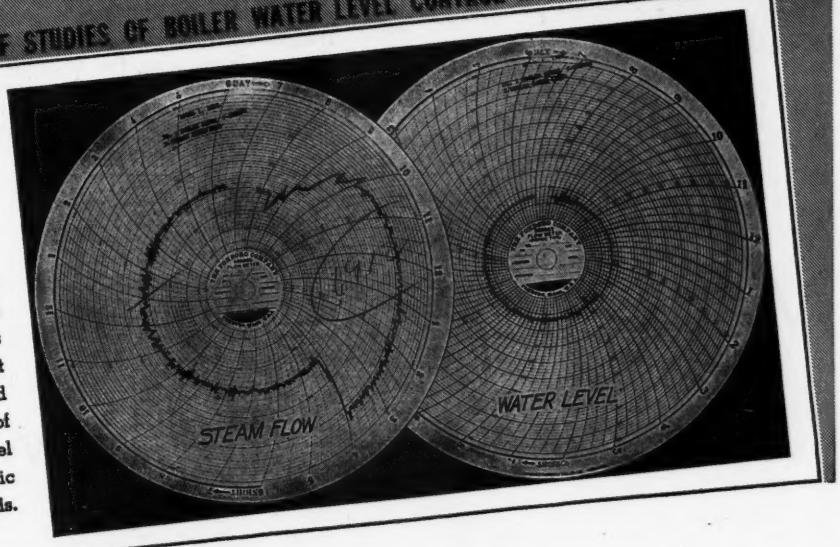
600 POUNDS W. S. P.

Firing with acid sludge or gas normal evaporation is as high as 350,000 lb. per hr. on this 600-lb. pressure Riley Steam Generator. Water level is carried one inch higher at 360,000 lb. per hr. peak load than at normal minimum of 242,000 lb. per hr. Level control by COPES Flowmatic is unusually close on all loads.



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Experience shows that changes in atmospheric temperature have no effect on the dependably accurate performance of the COPES Flowmatic Regulator. This installation, for example, is all outdoors and temperature changes of 80 degrees F. have not interfered with correct feed regulation or water level control. Nor has there been need for factory service. This Flowmatic, cut into service and accurately adjusted by plant personnel, has worked well for more than two years with only routine inspection and care. Write for Bulletin 409-B describing the simplified two-element steam-flow type COPES Flowmatic Regulator.

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This modern non-destructive method of crack detection is being consistently used with excellent results by many of the larger industries, and has become a valuable asset to power plant managements, not only in reducing the accident frequency, but also in permitting the continuous operation of equipment, by finding flaws and enabling replacement of parts before breakdown, thereby reducing the outage, which sometimes entails considerably more expense than the actual cost of repairs and replacements.

Magnaflux Inspection In the Power Plants

By J. J. TIMMONS

APPLICATION of the magnaflux inspection process is confined to those metals that can be magnetized, and, therefore, it cannot be employed on non-magnetic austenitic steels, such as the 18 per cent Cr., 8 per cent Ni. grade. The parts to be inspected are first magnetized (the tendency is to overmagnetize the piece under test so some care and attention is required in determining whether the part is properly magnetized), either by the use of a special magnaflux set or an electric welding set.

The magnaflux set is a portable apparatus consisting of two electro magnets, which can be used on an electric circuit of 110-220 v. alternating current, or 110 v. direct current. This set can be used on all small pieces, but when large equipment is to be tested, such as turbines, boilers or large pressure vessels, the object can be more conveniently magnetized by wrapping with 2/0 wire and attaching to a welding set having a current source of 100 to 300 a. and 5 to 10 v., the amount of cable required, usually from 6 to 10 turns of the wire, being a variable dependent upon the type of equipment under examination.

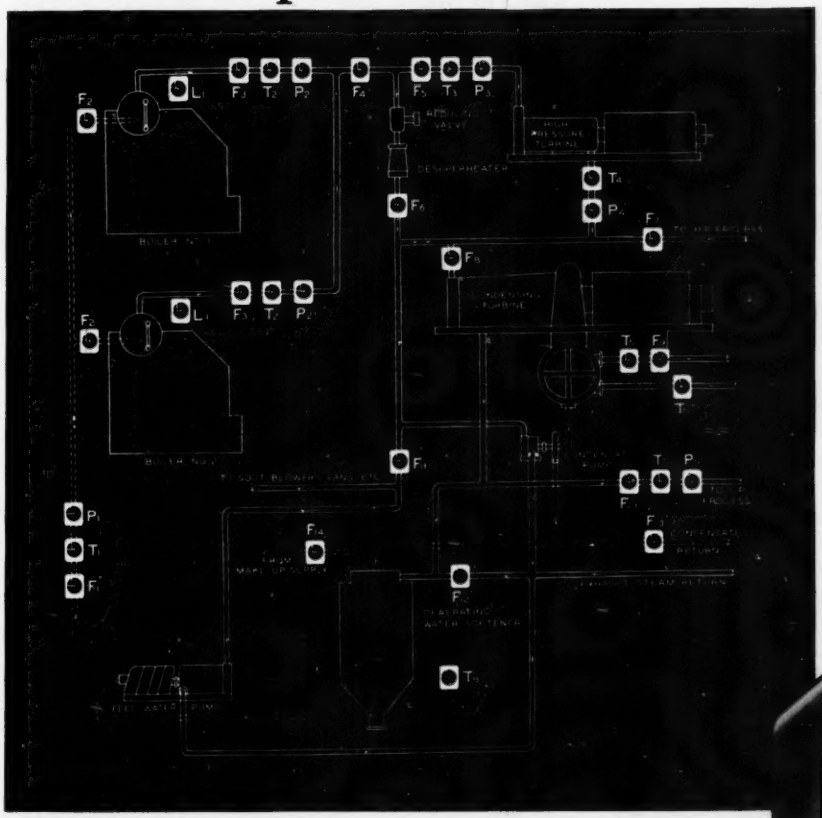
When the parts to be examined are sufficiently magnetized, any existing cracks may be readily found by dusting on the surface a fine metallic powder (furnished in black or gray), which, if cracks exist, will be drawn into the crevices, since the powder tends to bridge any gap or fissure. The powder is of high magnetic permeability, offers a low resistance path, and as a corollary rigidly affixes itself in the path of any flux leakage so that even a strong current of air will not remove the powder when it is adhering to a crack. If alternating current is used, it is not necessary to tap the metal to discover cracks, but with direct current, the metal should be tapped so that the powder can adjust itself along the line of any defect. In cases of doubt a fine sandpaper can be used and the area again dusted with the powder to determine whether the defect might be a scratch or tool mark, and in the case of infinitesimal cracks a low power magnifying glass may be used to be certain that the defect is actually a crack.

Doubtless the reader is familiar with the various types of defects which are commonly found on power plant equipment, but it seems apropriate to enumerate some of these defects and explain how this modern process may be used in lieu of the older more tedious methods of crack detection.

Boiler Defects Indicated

In many instances hazardous defects have been found by this test on steam boilers and no doubt disastrous explosions have been averted. It can be readily applied to check fire cracks in girth seams, breaks in bridges between tubes, such as in waste heat boilers, lap seam cracks, so-called caustic embrittlement cracks, cracked tube ends, defective mud drum heads and other parts of boilers. If, for example, an entire boiler is to be tested, 6 or 8 rivets should be removed from the longitudinal seams and a few from the girth seams, then it can be wrapped with 2/0 cable and magnetized by using a welding set. Then the powder is lightly sprinkled over the boiler surfaces and it is checked for defects. The rivets are removed for the purpose of checking the inside surfaces of the shell plates and butt straps. Whether or not it would be necessary to remove the butt straps for closer examination would be dependent upon the results secured and other analyses of the plant, such as types of water used in the boiler, its age and condition, and operating conditions. It is not mandatory to have the surface under examination scrupulously clean, and a light thin scale will not arrest the detection of cracks if they are existent.

Cochrane Flow Meters
—for every boiler and turbine room requirement—keep accurate records of performance and costs



FLOW RECORDERS

F 1—Total Feedwater Flow
F 2—Boiler Feed Flow
F 3—Boiler Steam Flow
F 4—Total Boiler Steam Flow
F 5—H.P. Turbine Steam Flow
F 6—Desuperheater Steam Flow
F 7—H.P. Process Steam Flow
F 8—L.P. Turbine Steam Flow
F 9—Circulating Water Flow
F10—L.P. Process Steam Flow
F11—Auxiliary Steam Flow
F12—Exhaust Steam Return
F13—Condensate Return
F14—Make-up Water to Softener

TEMPERATURE RECORDERS

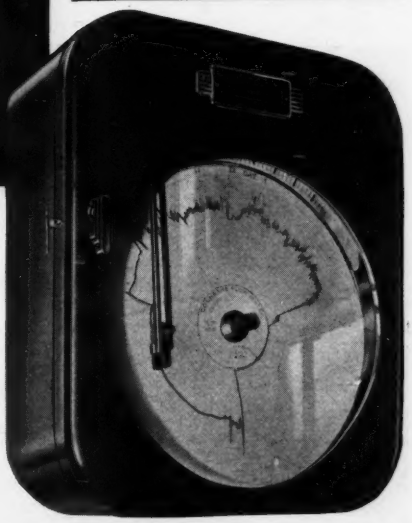
T1—Feedwater Temperature
T2—Boiler Steam Temperature
T3—H.P. Turbine Steam Temperature
T4—Steam Temperature from H.P. Turbine
T5—Inlet Water Temperature to Condenser
T6—Outlet Water Temperature from Condenser
T7—L.P. Process Steam Temperature
T8—Treated Water Temperature

PRESSURE RECORDERS

P1—Feedwater Pressure
P2—Boiler Steam Pressure
P3—Steam Pressure to H.P. Turbine
P4—Steam Pressure from H.P. Turbine
P5—Process Steam Pressure

LIQUID LEVEL RECORDERS

L1—Boiler Water Level



THE DIAGRAM above illustrates the application of Cochrane Flow Meters, Liquid Level Meters, Pressure and Temperature Recorders to a typical modern boiler plant and turbine room. Instrumentation for individual plants will vary according to conditions. Consult the Cochrane representative on your own problems or write direct to the Cochrane factory for details on the method of flow measurement and transmission to recorder by the galvanometer null principle described in Publication 2096.

Cochrane Flow Meters turn hidden losses into savings.

(OCHRANE Flow Meters permitted one firm, in testing 15 different coals for burning efficiency on their own grates, to select a coal that produced steam for 16.73c per 1000 pounds. In another plant a daily saving of $33 was made by eliminating excessive steam consumption. Another Cochrane Flow Meter was responsible for a saving of $2841.60 annually.

COCHRANE CORPORATION • 3123 N. 17th St., Philadelphia, Pa.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS

If the older methods were employed in checking for cracks, they might be detected in some cases by heating the plate and after it cooled checking the local area for defects. Or, it might be necessary to revert to the destructive method of cutting away small sections of the plate, such as veeing out a section of a lap joint, or cutting out a small coupon from the straps or seams to determine if a fissure existed. If rivets were removed, it would be necessary to polish the holes with acid and then examine with a magnifying glass, which is, of course, a very arduous task.

On pressure vessel work, this process is a valuable aid and is being closely allied with X-ray in cases where X-raying cannot be properly accomplished, such as nozzles and supporting lugs. Often a vessel is X-rayed and then stress relieved, which process is likely to evolve cracks, so that as a supplementary check the vessel may be subjected to this inspection. So also, in the case of code vessels coming within the scope of Class 2 and Class 3, where X-raying is not required, it may be utilized to check the welded seams for flaws. Generally, these A.S.M.E. vessels are tested at twice their working pressure and here again the test can be very well used to check the vessel after the application of the hydrostatic test.

Checking Turbine and Engine Parts

Examination of turbines, steam and Diesel engines required the utmost care by the older methods and even then the results secured were not always satisfactory, since they were dependent upon the keenness of the inspector.

Fig. 1. Cracks in spokes of flywheel

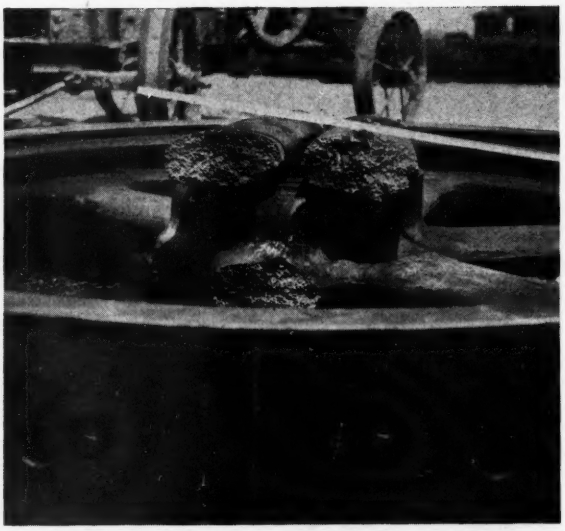


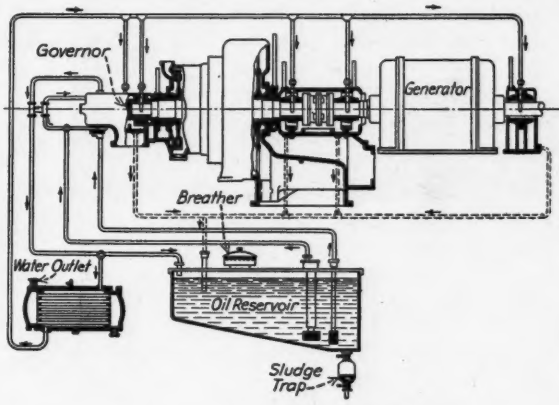
Fig. 2. Broken spokes indicate progressive type cracks

It is known that trained men were required to search for cracks on steam turbines, and these men knew from experience where cracks might possibly prevail. In carrying out the inspection special lights and lenses were used. This was supplemented by the whiting test, and after the whiting dried, the turbine blades were vibrated and then checked for cracks. In this type of test divers causes might intervene to give erroneous results and in many cases important flaws were overlooked. Then too this method of inspection was crude and very expensive as compared with the newer method, which can be conducted with rapidity and accuracy. Shafts, disks, blades and all other parts of turbines may be wrapped and magnetized and then dusted with powder, and cracks if existant will be revealed immediately.

On engines a magnifying glass would be employed in many cases in searching for defects at the most vulnerable points and the whiting test would also be used. This might require hours before the oil penetrated the whiting, especially if the crack were a minute one. So also, a very fine crack was likely to be overlooked if all of the oil were absorbed in wiping the part before the application of the whiting. With the use of this new method, positive results are assured. It is also highly useful in testing the crank shafts of Diesel engines, especially around the webs, which, due to high stresses, have a tendency to distort and crack. In the case of Diesel engines, care should be exercised to make certain that the powder does not become lodged in parts which might be injurious to bearings.

Figure 1 shows a 6-ft. flywheel with four cracked spokes, which were discovered by the use of magnaflux. It will be observed from Fig. 2 that the cracks were of the progressive type and had reached the state where an explosion of the wheel might have ensued if the cracks had not been found.

A LITTLE EXTRA HEAT GOES THE WRONG WAY



LAYOUT OF TYPICAL TURBINE PRESSURE CIRCULATING SYSTEM

An important function of a turbine lubricant is withstanding the effect of excess temperatures

YOU operators make heavy demands on the lubricant that protects your turbine bearings. For you often run them continuously for months—even years—at a stretch.

Turbine rotors, some of them, weigh many tons. And your only protection against loss of the bearing, against costly shutdowns, rests in a film of oil, at times no thicker than a piece of tissue paper. If it gives way for an instant . . . you pay.

Heat—and Your Oil Film

No, the right oil doesn't give way . . . not if it is so refined that it retains all its effectiveness in service. But from the moment it goes to work for you, it is constantly beset by heat—the enemy whose chief joy in life comes from breaking down an oil. Take away heat, and your lubricant, despite aeration and contact with metals and with water, does not markedly change its structure.

But You Can't "Take It Away"

Designers and operators of turbines have done and are doing all they can to keep down bearing temperatures. As you know, they have improved them . . . by adopting water-cooled bearings, by water seals between turbine housing and bearing, by oil coolers, by circulating systems which insure plenty of oil. Despite all their efforts, bearings keep on getting too hot for comfort—the oil's comfort.

And you know why: Some superheated steam is bound to leak through the gland seals. Some heat is bound to travel across from the rotor shaft. Bearings occasionally develop tiny "hot spots," which raise the temperature. All these increase the normal frictional heat induced by the rotor shaft's high speed.

What Twenty Degrees Can Do

The trouble is not, of course, that turbine bearing temperatures are excessively high. Somewhere between 110° and 160° F. is normal for most circulation-oiled bearings. What does make your lubrication difficult is that such a slight increase in temperature causes such a big increase in rate of oil oxidation. Did you know that an increase of only 20° F. *can double the rate of oxidation?*

When Oxidation Strikes

Without excess heat, there is little oxidation. But since you always do have excess heat to some degree, let's run over some of the evils that result from oxidation. 1. Your oil tends to break down, then emulsifies. 2. A vicious circle starts when insoluble sludge is deposited on cooler coils (more heat!). This sludge may also clog oil-supply lines and, in the governor, may keep your valves from seating as they should. 3. Finally, too-high temperatures may form active acids which, with water, may corrode bearings, governor and surfaces of cooler.

• • •

The operator of a turbine can control the heat only to a limited extent. He can take extra care that glands don't leak. He sees to it, of course, that sludge is thoroughly cleaned out when oil is changed. He chooses his lubricants with the aid of lubrication men who have a broad experience in specifying turbine oils that resist heat under the actual working conditions of many different designs. Shell has been able to improve lubrication and lower costs in many turbines. What is your problem? Let us help you.

SHELL

SHELL TURBO OILS

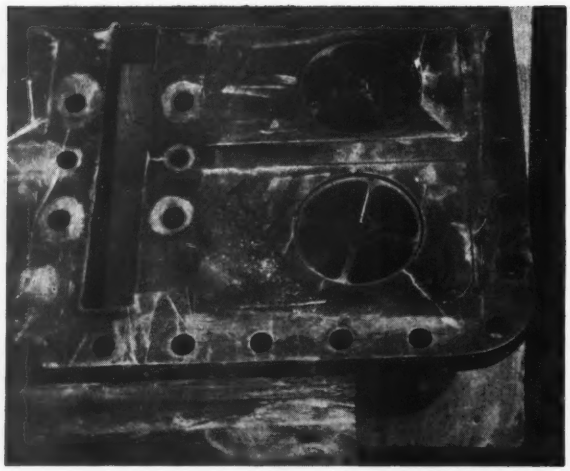


Fig. 3. Cracked valve plate of ammonia pump

Figure 3 shows a valve plate from an ammonia pump and it can be clearly seen how these cracks were made discernible by this process.

It is acknowledged that with this method of testing one has to be especially careful to differentiate between scratch or tool marks and cracks, such as at key ways, but with some practice this discrimination can be readily made and the use of a small magnifying glass will aid in verifying the results.

While it is not known how many companies are today using this process of crack detection, it can be safely stated that the more prominent ones are using it with invaluable results. The process is controlled by the Magnaflux Corporation and, of course, it is necessary to become a licensee before the process can be used by any individual or corporation.

Information Assembled on Ferrous Metals

AT A COST of $271,700, American manufacturers, research institutes, technical societies and federal bureaus, through the work of the Iron Alloys Committee of the Engineering Foundation have assembled a mass of hitherto inaccessible information from scientific and technical literature of many nations having to do with the knowledge of steel and iron and their alloys. This first critical review of its kind ever attempted is the result of ten years of research work on the part of the committee and will be of incalculable value to industries producing and using iron and steel and their alloys.

Approximately 10,000 papers have been read, and 20,000 abstracts have been prepared. Out of this mass of material, embracing international progress recorded since 1890, ten monographs containing 5630 pages have been issued.

Of the 6218 papers utilized in these publications, the United States contributed 2708 or 43.5 per cent. Germany was second with 1578 or 25.5 per cent; England was third with 1188 or 19.1 per cent; France was fourth with 407 or 6.5 per cent; and Japan was fifth with 203 or 3.2 per cent. Sweden is credited with 71 or 1.1 per cent; Russia with 24 or 0.4 per cent; Italy with 23 or 0.4 per cent; the Netherlands with 11 or 0.2 per cent. Five papers or 0.1 per cent originated in other countries.

This review of the literature includes data on the alloys of 40 elements with iron, in 20 classifications covering all phases of the manufacture, constitution, and properties of high-purity iron and plain and alloy steels and cast irons.

Four additional monographs are planned. The original program of the alloys of iron research will be finished early in 1943. The committee recommends that thereafter an annual appropriation of about $15,000 be made so that the monographs may be revised and brought up to date at regular intervals.

The monographs were compiled under the direction of the twelve members of the Iron Alloys Committee, and of outstanding metallurgists and representatives of other technical fields. In addition, a large number of research workers supplied unpublished data. They include nearly 200 Americans, eight Englishmen, seven Germans, two Czechs, two Japanese, and two Swedes.

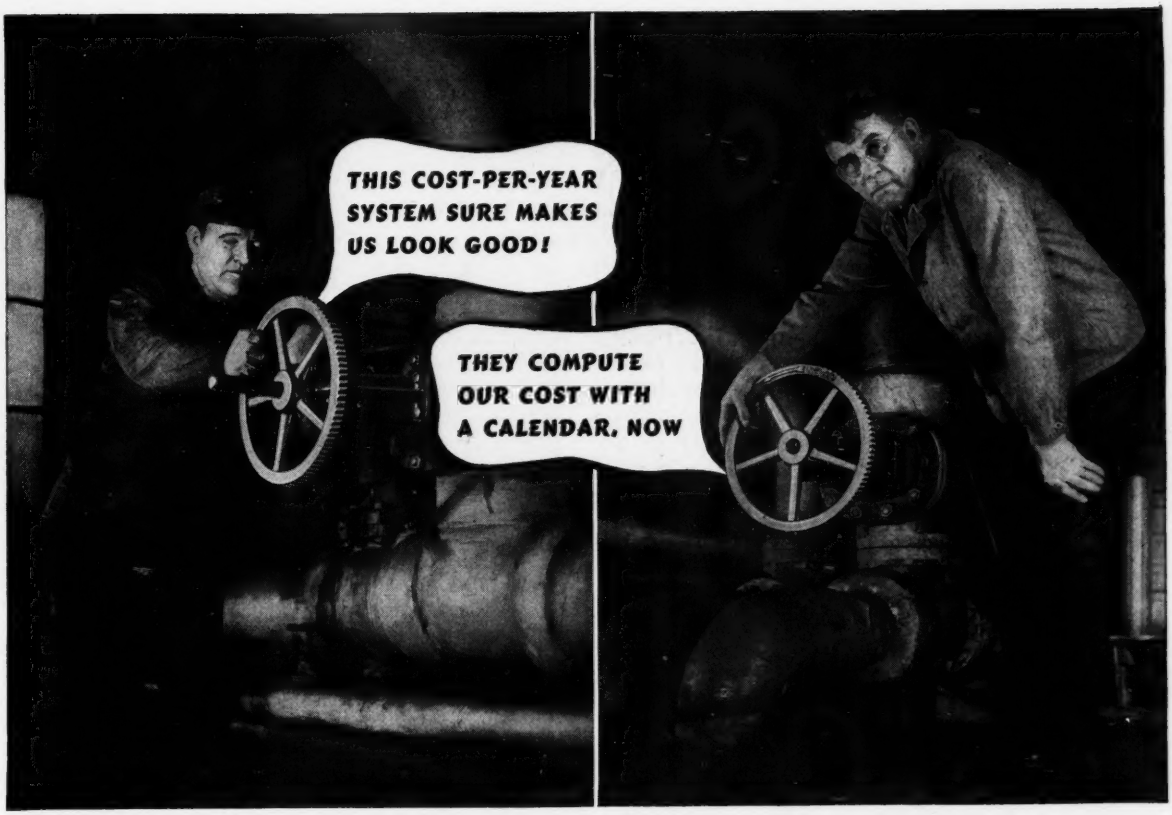
Users and makers have acquired knowledge from experience and research. A vast literature has accumulated, in many languages, marred by errors, disagreements, and gaps. It contains much of value and rapidly increases in volume. It must be consulted, but lack of orderly arrangement, of classification, of evaluation, of accessibility, and of generalization causes much waste of time and money. Facts are hidden from many persons who could use them profitably.

The program of the Iron Alloys Committee was planned broadly so that, by the publication of the monography series, metallurgists and other research students would be spared the labor and time necessary to search the literature in many languages to discover what had already been done in their chosen fields, and so that costly research work that duplicated research already completed, but reported in other languages or in obscure journals, could be prevented.

In addition it was planned that these monographs should supply in compact and readily usable form, all important data on the properties of present-day ferrous materials, to engineers and others making or using steel and cast iron.

Monographs already available deal with alloys of iron and molybdenum, alloys of iron and silicon, alloys of iron and tungsten, alloys of iron and copper, principles of phase diagrams, the metal—iron, alloys of iron and carbon, alloys of iron and chromium, low-chromium alloys, alloys of iron and nickel, special-purpose alloys and high-chromium alloys.

Professor George B. Waterhouse of the Massachusetts Institute of Technology is chairman and director of the committee.



25 YEARS ON 135 LB. STEAM

and still going strong!

The City of Salem installed five big Jenkins Cast Steel Gate Valves in their pumping station at North Beverly, Mass. It was extremely severe service, handling super-heated steam at 660°F, 7 days a week, 24 hours a day.

Each valve cost $145.85 new in 1915. "Only maintenance", Ralph Dutton, Chief Engineer says, "has been four repackings . . . and they're still going strong".

Let us suppose that one of these valves was not a Jenkins and had to be replaced in 12 or 13 years (still reasonably good service). That valve would have cost the City of Salem just *twice* as much per year.

This is the simple logic on which most Jenkins Valves are bought . . . and is backed by thousands of case histories throughout industry, of lower cost-per-year service.

JENKINS BROS., 80 White St., New York, N.Y.; Bridgeport, Conn.; Boston; Atlanta, Ga.; Philadelphia, Pa.; Chicago, Ill.; Houston, Texas Montreal, Canada London, England

TRY THE COST-PER-YEAR TEST

on these Jenkins Cast Steel Valves

Initial Cost *(5 valves)* .	$729.25
+	
Maintenance	7.50
÷	
Years of Service	25
=	
Cost per Year (per valve) . .	*$5.89*

IN VALVES *Jenkins* GIVES YOU EVERYTHING

Historic Turbine Goes To Smithsonian Institution

AN EARLY Parsons' reaction-type steam turbo-generator has recently been acquired by the Smithsonian Institution in Washington, D. C. Only two of these early engineering relics are known to be in existence today—the sister unit of this one being a treasure permanently kept in the South Kensington Museum at London.

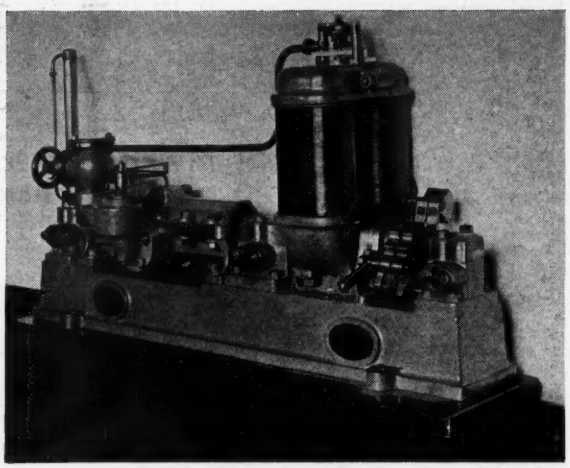
Sir Charles A. Parsons was the originator of the reaction-type steam turbine, which experience has shown to be the basic development that made possible the modern high efficiency steam turbine. His first units were built in the shop of Messrs. Clark, Chapman, Parsons and Company, Gates Head Works, England, during 1884 and 1885.

The unique unit acquired by the Smithsonian Institution was constructed in 1885. After operating commercially for many years, it was presented, in 1912, to R. A. McKee, who was Manager of Allis-Chalmers Manufacturing Co.'s Steam Turbine Division until his death in 1915. It was given by Mr. Parsons himself as a personal token of appreciation of work done by the Allis-Chalmers Manufacturing Co. in furthering the development of Parsons' reaction-type steam turbines. It has been in the custody of that company ever since.

This original unit had a rating of only 10 effective horsepower, width of only 12 in. and an overall length of 5 ft. It operated non-condensing, and was direct coupled to a Parsons' direct current dynamo which was only 14½ in width.

The steam enters at the center and flows axially in both directions to opposite ends of the cylinder. The blade rings are made up of solid rings of gun metal, strung on the shaft and the blades are cut out of the solid rims of the rings at an angle of about 45 deg., the inlet edges of the blades being sharpened. These blades vary in length and pitch according to the stages and expansion in the cylinder. The oil for lubricating the bearings is contained in a chamber at the end of the turbine and is fed by a vertical standpipe. There are separate delivery and return pipes to and from all of the bearings. Between the turbine and the bearings on the end opposite to the generator is a fan composed of a solid disk, having passages drilled radially, connecting with transverse holes near the shaft. This fan, or blower, acting through a small pipe connecting with the top of the vertical standpipe, creates a partial vacuum in the standpipe. This partial vacuum raises the oil level in the standpipe and primes a worm on the end of the turbine shaft which acts as an oil pump and maintains a constant circulation of oil through the return pipes, bearings and delivery main.

For governing the speed of the turbine there is provided a leather diaphragm connected to the fan mentioned above. As the speed rises, the vacuum induced by the fan increases and tends to collapse the diaphragm. A spiral spring is provided to balance or counteract the vacuum. This spring is loaded according to the maximum speed desired and when the turbine speed increases above the desired speed the action of the fan creates an excessive vacuum, overbalancing the spring and operating the throttle valve regulating the admission of steam to the turbine. The turbine speed is further regulated by electrical connection with the dynamo to which it is coupled. A soft iron bar will be seen pivoted on the vertical spindle on top of the field magnets of the dynamo and this bar carries a pointer, ending in a guard covering the inlet to the pipe which is shown extending from the top of the dynamo to the governing diaphragm.



Parsons' Turbine to be Placed in Museum

The polarity of the magnet tends to place this bar parallel to the lines of force and this tendency is resisted by a spring, the tension of which is adjustable. When the magnets are shunt-wound and the iron bar is far from saturation, the intensity of the magnetization varies as the electromotive force varies at the terminals and when series-wound it varies as the current and this variation is reflected in the operation of the bar. When the resistance of the spring is overcome, the movement of the bar varies the opening to the air pipe and acts through it on the vacuum behind the diaphragm, in this way throttling the steam to the turbine according to the extent of the movement of the bar combined with the suction of the fan.

PRECISION cutting nozzles are now available which make cuts of such exceptional quality that usually no subsequent machining is required. The cutting oxygen passage is highly polished, thus producing a smooth gas flow without deflection or turbulence. This results in a clean, unbelievably smooth face or cut. The preheat holes are smaller and spread over a larger circle so that the heat is less concentrated on the line of cut. This results in a squarer, cleaner, sharper upper edge, a small kerf, and a saving in preheat gases. The cutting oxygen passage is exactly vertical when the blowpipe is vertical, so that when cutting shapes or circles, the face of the cut is exactly true all around.

The Case of the DEADLY THIRST

SOLVED WITH PREVENTIVE MAINTENANCE

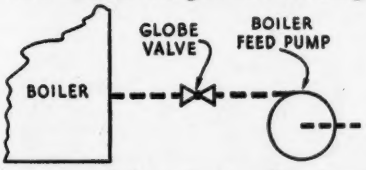
"Killing that boiler will cost us real money," shouted the SUPERINTENDENT. "We can't keep up with orders now!"

"It might have been lots worse," sighed the PLANT ENGINEER," . . . if we hadn't located the trouble in time."

"But, it won't happen again," said the CRANE MAN," . . . now that you've applied Preventive Maintenance with the right Crane valve."

THE machinery in a manufacturing plant was humming gaily to the tune of big orders. But one day the hum quieted. One of the high pressure boilers had to be "killed." A valve in the feed water line jammed; the fire had to be pulled or the thirsty boiler would burst.

The valve was a gate with rising stem and solid wedge disc. Throttling



service and the pulsating flow from the feed water pump were more than it could stand. Vibration of the disc cut the stem in two. The disc dropped, and seating itself, tightly shut off the line.

To make repairs by the rule of ordinary maintenance would be folly. Only a valve that would prevent recurrence of such trouble would do. And that's how Preventive Maintenance—recommended by G. L. C., the Crane Representative—came into the case.

For two sound reasons Preventive Maintenance prescribed a globe valve with plug type disc. *First,* it could be installed with pressure under the disc, and should the valve fail, it would not stop water supply entirely. *Second,* its plug type disc and seat would offer maximum resistance to the severity of throttling service.

Results: (1) the trouble was remedied. (2) The threat of another costly boiler shutdown due to misapplied valves was removed. (3) Another manufacturer has learned that Preventive Maintenance is sound economy; and that Crane offers not only the most complete and dependable source of valves and fittings, but accurate information on application as well. He knows, too, the wisdom of consulting the Crane Salesman on every piping problem—big or little.

This case is based on an actual experience of a Crane Representative in our Oshkosh Branch.

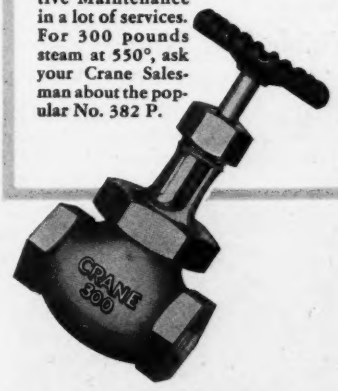
CRANE BRASS PLUG DISC VALVES TAME POWER PLANT FLOW

In your boiler room—in lines where the service is really tough, you'll find these valves exactly right for the job to be done, right for the safety required. Use them for throttling, in soot blower, blow off, boiler feed, in drip and drain lines.

Crane brass plug type disc globe valves are extra strong and durable; they're made of a high grade steam metal. Their wide seating area is designed to resist the damaging effects of wire drawing and foreign matter. The disc taper assures tightness; permits easy regulation of flow.

Their discs of nickel-alloy and seats of exelloy are a tough combination that gives stubborn opposition to wear, wire drawing and galling.

Available in complete range of pressure ratings, these valves are ideal for Preventive Maintenance in a lot of services. For 300 pounds steam at 550°, ask your Crane Salesman about the popular No. 382 P.



1940 our 85th YEAR

CRANE

CRANE CO., GENERAL OFFICES
836 S. MICHIGAN AVE., CHICAGO
VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

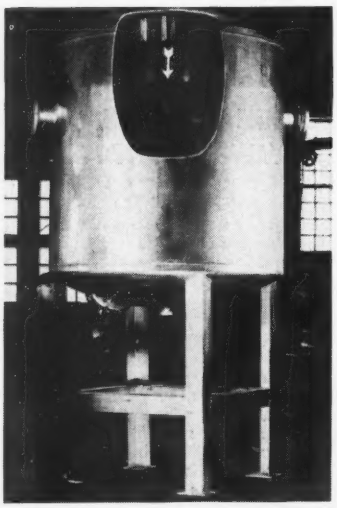
NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Receiver-Purifier

CENTRIFIX CORP., 3029 Prospect Ave., Cleveland, O., has placed on the market a new type of receiver-purifier which has expansion and contact capacity sufficient to condense oil vapor in exhaust steam lines. The design is such that after the oil is condensed it



is easily removed by the Centrifix Internal Purifier. This drum proper is 6 ft. in diameter and 13 ft. high. It is for installation in a 14-in. exhaust steam line. The high efficiency of this Centrifix is its principal characteristics. There are no moving parts, is self-cleaning and therefore economical of operation and maintenance.

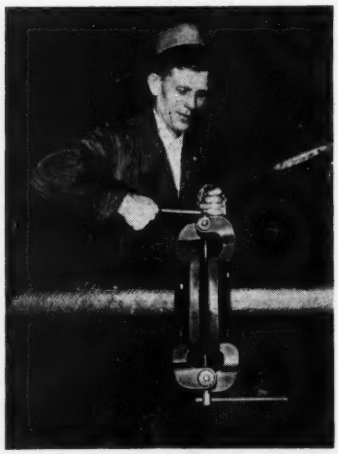
Visible-flow Fitting

THIS visible-flow fitting has been developed by Cochrane Corp., 17th St. & Allegheny Avenue, Philadelphia, Pa., to provide continuous checks on operation of equipment and observe the fluid in

flow under pressures up to 125 lb. per sq. in. and to facilitate the observation of the duration of the blow-off from hot process softener sedimentation tanks. The Cochrane Sight Glass has been designed in six sizes for from 2½ to 8 in. lines for any purpose where visual inspection of fluid flow is desired. Body is of cast iron and the window frame is of steel. Windows are made of Pyrex glass. The sight glass fitting is flanged for installation in the line and all sizes measure 13¼ in. between finished surfaces. Windows are 4¼ in. in diameter for all sizes.

Flange Jacks

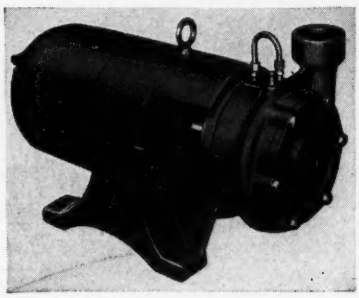
THE GARLOCK PACKING CO., Palmyra, N. Y., announces a new simple tool for replacing gaskets on flange pipe lines. Flange jacks are always used in pairs. After removing two bolts from the flanges at 180 deg. from each other, place one of the jacks in each of these bolt



holes and tighten up the screw just enough to hold the jacks in position. Then the remainder of the bolts may be removed. Tightened down the jackscrews will cause the flanges to separate so that the new gasket can be inserted. This tool is available in three sizes, for pipe under 2 in., for pipe 2 to 20 in. and for pipe 14 to 48 in.

Balanced Monobloc Pump

A NEW balanced Monobloc centrifugal pump, wherein the motor and pump have been engineered as an integral unit of balanced functional design in contrast to merely adapting a motor to a pump, is just announced by the Worthington Pump and Machinery Corp., Harrison, N. J. It is exceptionally compact, requiring a minimum of floor space, yet is provided with ample room for repacking the stuffing box. A shaft of large diameter, on rigid bearing mountings, maintains concentricity in all rotating parts, thereby increasing packing life. The new drip-proof motor features a directed flow of ventilating air which prevents drawing of moisture into the motor. This



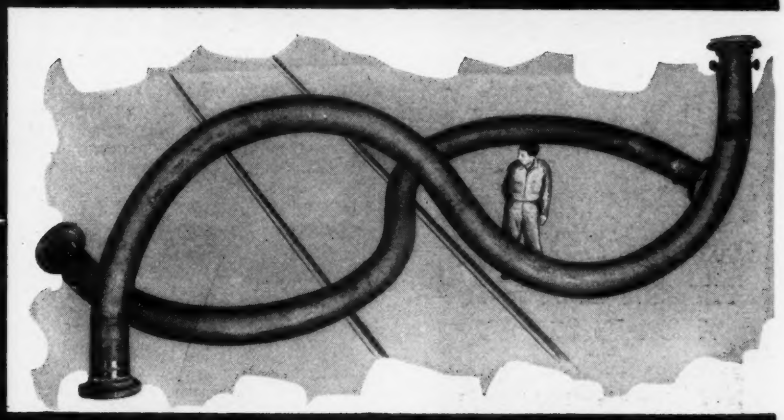
new Monobloc unit is offered in sizes of from 1 to 4 in. with capacities to 1000 g.p.m. against heads up to 280 ft. It is available in bronze fitted, all-iron and all-bronze construction, horizontal or vertical mountings, with motor of any electrical characteristic.

Traps

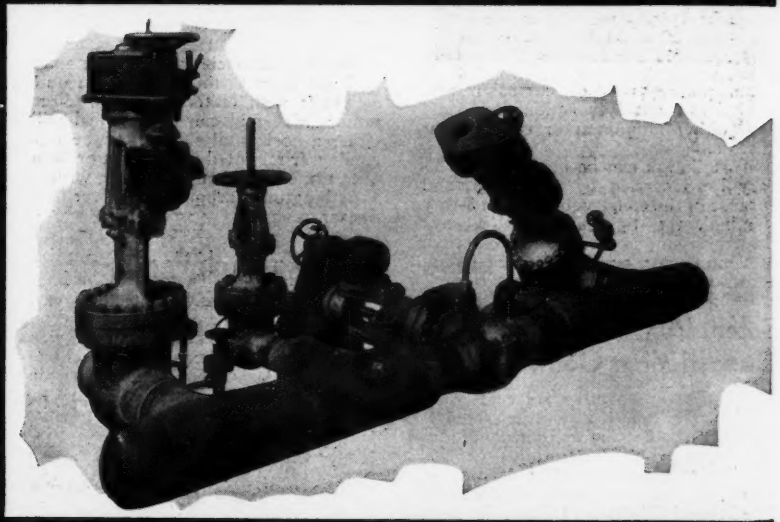
TWO NEW TRAPS, identified as No. 19 and No. 20, have been announced by the V. D. Anderson Co., Cleveland, Ohio. The head and body are connected together with four bolts in a flange type

connection. These traps have a bronze hexagonal bucket guide and the valve and lever mechanism is of a new design with no pins or pivots. The new design makes it possible to have a drain plug at the bottom. The maximum operating pressure is 200 lb.

MIDWEST *Alloy* PIPING



14" O.D. Chromium-Molybdenum pipe bends with Van Stone laps. Entire bends annealed after fabrication.



Carbon-Molybdenum header stress relieved in furnace before welding on valves which were welded by preheating and stress relieving with induction method.

PRESSURE piping users have found that alloy tubing presents many problems and difficulties not encountered when low carbon steel materials are used. Some have learned by bitter experience that the utmost care must be exercised in selecting a fabricator . . . one who has wide experience in the special manufacturing procedures required by the various alloys. It is also essential that the fabricator's welders be skilled on welding alloy tubing . . . and that he have the heat treating furnaces and other special equipment needed.

Each of the three Midwest plants is thoroughly familiar with all the "do's" and "don'ts" peculiar to the fabrication of alloy tubing. Midwest has welders qualified on the alloys . . . and Midwest has the special equipment so essential to the successful fabrication of alloy tubing.

Whenever you need alloy piping, you will find it definitely advantageous to get in touch with the nearest Midwest office.

MIDWEST PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 S. Second Street, St. Louis, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles • *Sales Offices:* Chicago—946 Marquette Building • Houston—1716 Second National Bank Building • Los Angeles—520 Anderson Street • New York—(Eastern Division) 30 Church Street • Tulsa—533 Maya Building.

Distribution Transformer

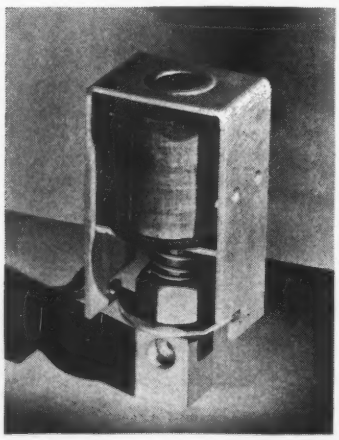
ALLIS-CHALMERS MFG. CO., Milwaukee, Wisc., has just announced a new distribution transformer embodying new features of design and construction. Cadmium plated 3-way terminals increase wiring flexibility over the former two-way terminals by allowing leads to enter the terminal from any one of three directions. No special fittings are necessary because the heavy cad-

mium plating reduces corrosion and minimizes electrolytic action when used with either aluminum or copper conductors.

Installation can be made with ordinary tools carried by a lineman, and because of the construction of the 3-way terminal, the tightening tool always travels in an up and down direction, preventing any accidental short circuit across the secondary terminals.

Solenoid Valve for Conditioning Control

A NEW, inexpensive solenoid valve particularly adapted to the requirements of the heating and air conditioning industry as well as to general applications in the control of air, oil, water, and gas was recently introduced by General Electric. It may be used

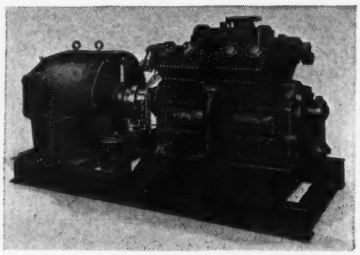


as water control for humidifiers, water control for laundry and dishwasher equipment, oil shutoff for oil burner service, pilot-gas control for gas burners, air control for compressed-air devices, or for evaporative cooling equipment.

Since it is designed to be incorporated into an assembly that has its own enclosure, no coil cover, conduit plate, etc., have been provided.

Refrigeration Compressor Unit

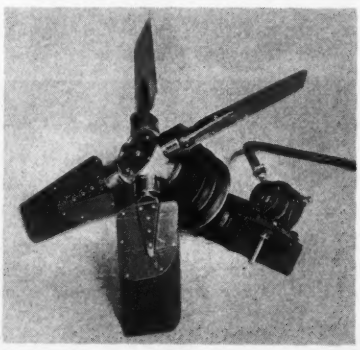
WORTHINGTON PUMP AND MACHINERY CORP., Carbondale Division, Harrison, N. J., are now offering refrigeration units with capacities ranging from 75 to 125 tons for single units and up to 250 tons with duplex arrangement. Although of sturdy construction, they



are light in weight and compact, providing large capacity where floor space or head room is limited. These units are built with either V-belt or direct motor drive and can be supplied with either a horizontal shell and tube type condenser mounted on the unit or without the condenser for use with a Worthington- Carbondale Shower Condenser.

Variable-pitch Fan

THERMOSTATICALLY controlled, variable-pitch fans for cooling many types of internal combustion engines were recently put on the market by Kontrol-Fan, Inc., Pasadena, Cal. The thermostat causes the variable-pitch fan blades to move into the correct position



for the necessary air movement to hold the desired temperature. Savings are accomplished by insuring efficient engine operating temperatures under all weather and load conditions. Both air and water-jacketed thermostats are available. When cooling is not required, the fan blades flatten out and take no power.

Non-Radiating Insulator

PORCELAIN PRODUCTS, INC., Parkersburg, W. Va., announces Type N glaze and Type N Non-radiating insulators. The glaze possesses all the characteristics of standard brown silicate glazes and achieves its interference eliminat-

ing feature through controlled conductivity which is the same throughout the entire thickness of the glaze and is not a surface or under surface treatment. The glaze adds to the strength of the porcelain, is smooth and will not cause conductor wear, and attack by nitric acid or sulphur dioxide fumes will not affect it or its interference eliminating characteristics.

Centrifugal Fan

B. F. STURTEVANT CO., Hyde Park, Boston, Mass., has made an addition to its line of centrifugal fans, the Silentvane Design 7, which is ruggedly constructed of heavy steel plate reinforced with angle irons. It is available in all standard discharges, single and

double width, single and double inlet, with wheel diameters ranging from 14⅝ to 87 in., static pressures to 16 in. w.g. Streamline inlets shaped to form whirl-free passages for the air to enter the rotor smoothly, reducing fan-eddy currents and turbulence, results in quiet operation. Freedom from dust loading in rotors or fouling when handling dirty gas or air is due to the use of straight fan blades pitched at an angle of 45 deg. at delivery. Comparative freedom from dust loading makes the design of this fan applicable for practically any dust handling application where the high efficiency and operating characteristics of the fan indicate its selection.

THERE IT IS . . .
without a doubt

Above is shown a reproduction from an actual unretouched color photograph which illustrates the appearance of the gauge glass from directly in front.

BECAUSE the liquid level in a "PYREX" Broad Red Line Gauge Glass is easy to see, from any angle and at greater distances, more frequent checking becomes a habit with boiler room attendants. Greater safety and efficiency is the obvious result.

The fused-in, permanent, broad red line produces a readily visible dividing line in the appearance of the gauge glass above and below the water level (see illustration). Either ordinary reflected light or rear illumination effectively reveals the exact liquid level.

Complete details on "PYREX" and Corning Gauge Glasses can be obtained from any of the leading steam and mill supply houses. Ask your dealer why these glasses are more efficient and more economical in the long run.

Pyrex GAUGE GLASSES

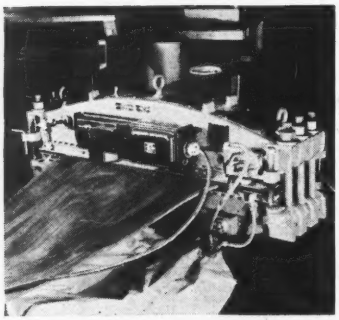
BRAND

CORNING GLASS WORKS, CORNING, N.Y.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works.

Belt Vulcanizer

B. F. Goodrich Co., Akron, Ohio, announces an addition to its line of belt vulcanizers, designated as the 36-42. The new vulcanizer, made for Goodrich by the James C. Heintz Co., has a platen long enough to span a 36-in.

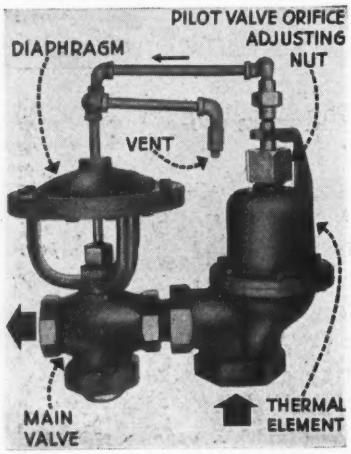


belt when the vulcanizer is clamped on the belt at approximately a 22½ deg. angle with reference to a line drawn at right angles to the edge of the belt. The platen measures 47 in. in width and 12 in. in length. The overall width is 54 in., the overall length 18 in., and the overall height 23 in. The total weight is 1145 lb.

Air Eliminator

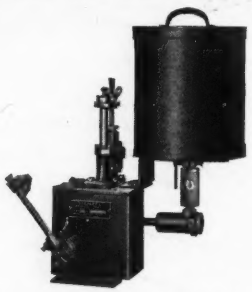
A new automatic valve, known as an Air Eliminator, is announced by the Armstrong Machine Works, 810 Maple St., Three Rivers, Mich. The unit consists of a conventional type of diaphragm valve to which has been added a special dome-shaped inlet chamber. Housed in the dome of the inlet chamber is a bellows type thermal expansion unit which raises and lowers a needle valve that seats against an orifice mounted in the top of the dome. This valve acts as a pilot valve to admit pressure to the top of the diaphragm. The other pipe above the diaphragm is fitted with a small relief vent which dissipates the pressure above the diaphragm when the pilot valve is closed.

A mixture of air and steam entering the 2 in. inlet cools the thermal unit, which contracts and opens the needle valve. This, in turn, applies pressure to the diaphragm, which is depressed, thus opening the main valve and permitting the steam-air mixture to escape through a 1¼ in. outlet. When the air has been exhausted, pure steam envelopes the thermal elements, causing it to expand and close the needle valve. With pressure relieved above the diaphragm, internal pressure forces the main valve to close. To make sure that the valve remains closed when steam is turned off, a small compression spring is placed under the end of the valve stem. The unit measures 12½ in. in height and weighs 30 lb., and has valve bodies made from bronze.



Chemical Feeder

Manzel Brothers Co., 327 Babcock St., Buffalo, N. Y., announces the addition to its line of a boiler compound feeder for automatically injecting boiler compound into the feedwater line. Attached to the boiler feed pump, the Manzel feeder injects exactly the desired amount of chemical into the feedwater line with each pump stroke.



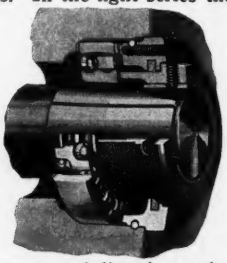
The amount fed is easily and accurately adjustable to meet the requirements of any water or boiler condition. The only part of the feeder coming in contact with the chemical is the individual pumping unit, a small single plunger pump. This is located outside the feeder body so that examination, repairs, or replacement can be easily made without dismantling the feeder. The entire driving mechanism is enclosed in an oil-tight case so that all driving parts operate in a bath of oil and are protected from dirt and dust.

Fuel Oil Treatment

Liquid Kleen-Flo, a catalyzing chemical suitable for use with all grades of fuel oil through the heavy bunker residues is offered by the Combustion Service Co., 1451 Broadway, New York City. This liquid, added down the fill line in the proportion of one gallon to every 2000 gal. of fuel oil, is said to give the hydrocarbon molecules the extra combustion properties necessary for high test premium performance. Advantages of the treated over regular fuel oil are said to be: prevention of carbon formation on burners and reduction in time required for cleaning of heaters; to quicken and more thoroughly complete the combustion process, thus improving flame characteristics; to reduce soot, smoke and discharge of stack solids; to reduce surface tension making the oil congeal-proof and induce clean ignition; and to chemically absorb water, thus removing tank bottom settlings, saving pump outages and improving plant operation.

Simplex Ball Bearing Units

Ahlberg Bearing Co., 3074 West 47th St., Chicago, Ill., has developed a line of bearing units known as CJB Simplex Machine Units which are available in three capacities; for light, medium and heavy loads, with either single row, double row or self-aligning bearings. In the light series the bear-

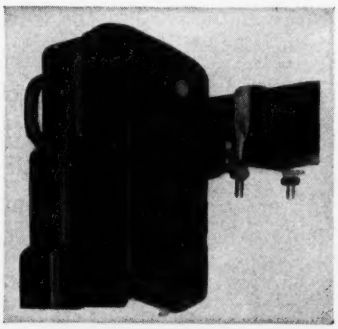


ings are mounted directly on the shaft; whereas the medium and heavy units mount through a split adapter sleeve in a tapered bore bearing. A new type, non-drag seal has been developed, using Neoprene as the sealing material. The design provides a labyrinth type seal which is frictionless and effectively prevents the entrance of dirt and other harmful substances.

100-Ampere Reclosing Fuel Cutout

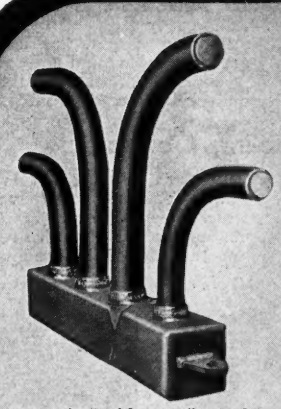
A 100-amp. reclosing fuse cutout in 5000-v. and 7500/12,500 Gr Y volt ratings is announced by General Electric. Similar in design to the company's 50-amp. reclosing cutouts but constructed for heavier current duty, the new cutout offers the same advantages of automatic reclosing, maximum economy, sleet proof design, and interchangeability.

The entire reclosing mechanism is in the door. The cutout functions by automatically connecting a second fuse link in the circuit one second after the first fuse link blows. When this takes place the door of the cutout is pushed open at the bottom and a red indicator, visible from the ground, appears. If the fault persists and the second fuse link blows, the door opens to a posi-

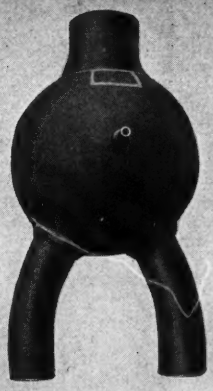


tion completely isolated from the circuit. The cutout will restore service after a temporary fault even when the door is firmly frozen shut with sleet.

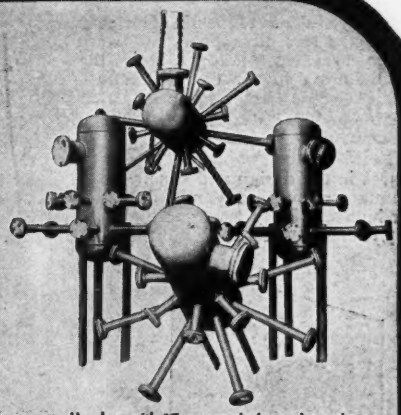
The cutout can be purchased complete, or the 100-amp. reclosing door can be purchased separately and put on any 100-amp. G-E indicating and drop-out cutout housing now in service at a cost which in some cases may be less than the cost of a single service outage.



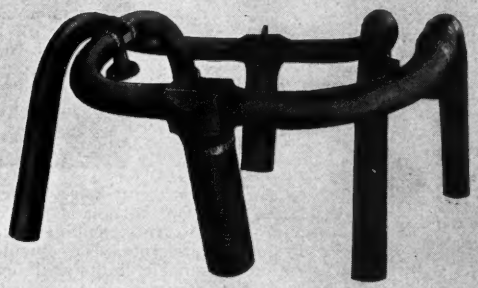
Main Boiler Feed for 2000 lb.—320° F



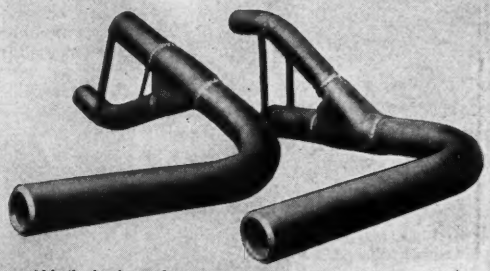
Spherical Steam Header for 1250 lb.—925° F



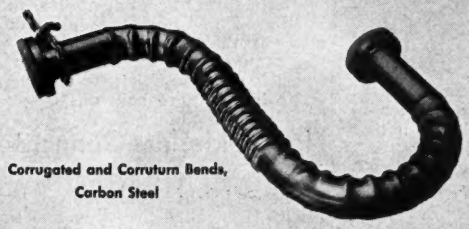
Headers with 17 accurately located nozzles—"Masterwelded"



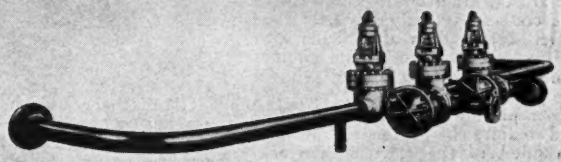
Prefabricated pipe assemblies for 1350 lb.—950° F



8" boiler leads—with 6" by pass connections—1750 lb.—450° F



Corrugated and Corruturn Bends, Carbon Steel



6" Steam Header for 725 lb.—825° F

THEY MAY LOOK FUNNY BUT— THEY'LL ALL DO A REAL JOB

KELLOGG

THE M. W. KELLOGG COMPANY

JERSEY CITY • NEW JERSEY • 225 B'WAY, N. Y.

REPRESENTATIVES

CHICAGO: 122 SOUTH MICHIGAN AVENUE

LOS ANGELES: 609 SOUTH GRAND • TULSA: PHILTOWER BLDG.

"**Masterflex**" Prefabricated Piping Systems · "**Masterweld**" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic Cracking Units. Thermal and Catalytic Polymerization Units · **JUIK Processes** for Lubricating Oil Plants. Plastic Refractories · Radial Brick Chimneys

Contactors

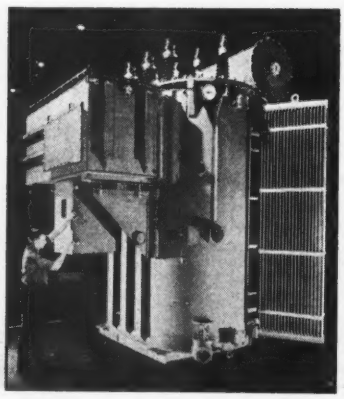
KNOWN as the 540 Line of D.C. Heavy Duty Contactors the apparatus shown on the attached photograph is the latest addition to the Cutler-Hammer line of electric motor control. It is available in 100, 150, 300, 600, 1200, and 1800 amp. sizes.

The 540 line embodies two new features in the design and construction of contactors for heavy mill duty. A new, high efficiency type arc blow-out quickly drives the arc from the con-

tacts to the large arc horns above the contacts. The instantaneous rupturing of the arc on the arc horns, instead of on the contacts, greatly prolongs contact life. Heavy duty arc shields with carbofrax inserts opposite the contact tips, lift off for inspection—as shown in the photograph—yet set firmly and solidly in place during operation. The second feature is in the design and construction of the electric interlock. The C-H Dust-Safe, Vertical Contact type of construction is used in these contactors. The pure silver contacts (not coin silver) are impervious to sulphur fumes and oxidation. The rollers, which actuate the mechanism, are made of long wearing bakelite.

Load-Ratio Control

ALLIS-CHALMERS MFG. Co., Milwaukee, Wisconsin, has developed a new transformer load-ratio-control mechanism—Type TLK—to supplement its already well-established Types TLF and TLB regulating mechanisms. This

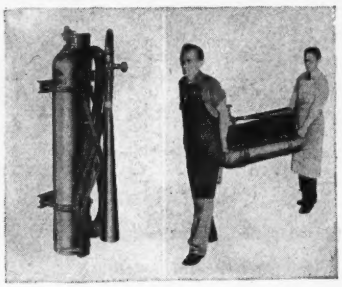


new mechanism is designed for application on medium-large regulating and power transformers, single or three-phase, and can be arranged for automatic or manual control. The type TLK design has dial switches and rotary-breakers mounted on separate oil-filled compartments with complete mechanical interlocking so that the tap changing circuits are closed and opened by the breakers while changing taps.

The uniquely designed rotary breaker opens and closes the tap circuit through a simple, reliable, quick-break spring drive similar to that used in the Allis-Chalmers highly successful Type AFR step feeder voltage regulators.

Fire Fighting Unit

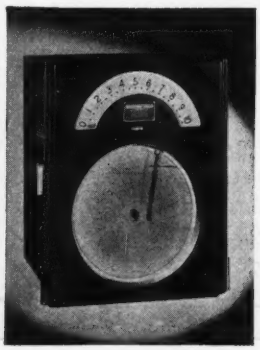
STATIONARY-PORTABLE FIRE FIGHTING UNIT, manufactured and sold by the C-O-TWO Fire Equipment Co., 10 Empire St., Newark, N. J., consists of a 50-lb. size cylinder of carbon dioxide, a 50-ft. length of high-pressure, reinforced flexible rubber hose and a large discharge horn fitted with a quick-opening type valve for controlling discharge of gas from cylinder.



It discharges clean, dry, non-deteriorating carbon dioxide which is a non-conductor of electricity and, by the pessure of its own expansion, carbon dioxide penetrates every crack and corner and snuffs out fire instantly. It is nondamaging to machinery, products or finishes.

Mechanical Ring-Balance Meter

A NEW mechanical meter of the ring-balance type for metering steam, water, gas, air, etc., at static pressures up to 1000 lb. per sq. in., has just been announced by Republic Flow Meters Co., Chicago, Ill. This new meter will give full scale readings on differentials as low as 3 in. of water, which is ideal for low pressure gas and air measure-



ment. The meter is housed in a rugged steel case suitable for exposed locations. It is easily adjusted by changing a calibrating weight, has a 12-in. evenly graduated chart and is furnished with any combination of indicator, recorder and cyclometer type integrator.

Cooling Controls

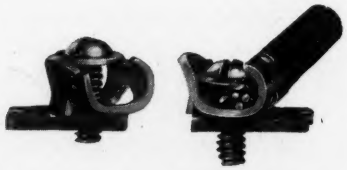
SARCO CO., INC., 183 Madison Avenue, New York, N. Y., announces new cooling controls. Figure 1 shows a thermostatic mixing or blending valve for controlling the flow of the cooling me-

dium either water or brine by recirculating a varying portion of the cooling fluid back to the equipment cooled. Pressure differences or fluctuations within reasonable limits will not disturb the controls because balanced valves are used.

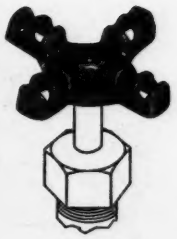
In the form of cooling control shown in Fig. 2 the flow of fresh cooling water is throttled in accordance with the temperature of the used water which is piped to flow over the thermostatic bulb of the control.

New Solderless Connector

A NEW solderless connector has been developed by the Square D Co., Detroit, Mich. It is called the Universal Speed Connector, because of its ability to take from No. 14 to No. 4 wire, and because it saves time in wiring. The connector is free to rotate around the screw, thus allowing wire to be inserted from almost any angle. This feature is important where large wires are used in a limited space. The unusual range in wire size (from No. 14 to No. 4) permits the use of large wires for service drops to small 30 or 60 ampere switches.



The connector is self-centering so that there is no need to wind the wire around the stud, or to separate stranded conductors. As the screw is tightened, the lug is forced to one side and the wire is gripped tightly. When the tightening is completed, the screw exerts pressure against the wire on one side and the lug on the other side. Thus, bending of the screw is prevented, while positive contact is assured.

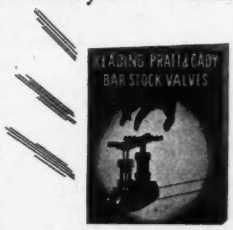


THE NEW HAND WHEEL FOR BAR STOCK VALVES

This new wheel provides an ideal grip for small valve operation—easier to operate under normal conditions and particularly valuable if workmen's hands or valve exterior are at all greasy.

For PRECISE, CLOSE CONTROL TRY BAR STOCK VALVES IN YOUR PLANT

There is a definite need for accurate, close control valves up to 1 inch that withstand practically all commercial temperatures and pressures. That is why Reading-Pratt & Cady developed Bar Stock Valves—turning them directly on precision-set machines from bronze, carbon steel, 12-14 chromium stainless steel, 18-8 Stainless Steel as well as from combinations of these bar stocks.



Write for well-illustrated bulletin that gives details of all types and capacities of Bar Stock Valves with prices. And ask for recommendations for their use in your plant.

The seats are plug type. The seating angle, long seat contact and fine pitch spindle threads make possible closest control and result in valves that are unusually reliable and durable.

Made as Globe, Cross and Angle Valves. Indicator, Welding End, Lock Bonnet, Lock Shield and Thru-Port types are among the available designs. Their capacities range from 4000 lbs. at 150° F. to 475 lbs. at 1000° F.

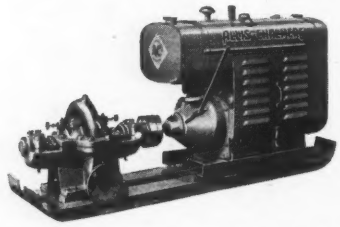
READING-PRATT & CADY

READING-PRATT & CADY DIVISION · BRIDGEPORT-CONNECTICUT

AMERICAN CHAIN & CABLE COMPANY, Inc.

Engine Driven Centrifugal Pump

THE ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has introduced a line of centrifugal pumps driven by gasoline power units. Power units are offered in five sizes from 18 to 110 hp. with a choice of fuels: gasoline, kerosene, distillate, natural gas, or butane. All power units have valve-in-head medium speed engines, with removable cylinder liners, efficient cooling sys-

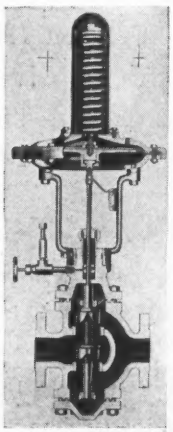


tems, force feed lubrication and a variable speed governor. The centrifugal pumps are horizontal shaft, single stage, single or double suction pumps designed for handling liquids at normal temperatures with maximum efficiency. To facilitate handling, the engines and pumps are mounted on a base and are available in many combinations to meet various requirements in quantity and pressure up to 5000 g.p.m. and 100-ft. head.

Stabilflo Valves

AN IMPROVED LINE of Stabilflo controlled valves designed for accurate response to the demands of a control instrument, without sacrifice of rugged construction, has been announced by The Foxboro Co., Foxboro, Mass.

As equipped with a wide range V-port plunger, the valve has a rangeability of 50 to 1. When this valve is lifted off the seats, the initial clearance flow is 2 per cent. From this 2 per cent flow to 100 per cent flow, the valve gives equal percentage increases in flow for equal amounts of valve lift. The V-port plunger is screwed and pinned to the valve stem and designed for easy field reversal. In addition to this V-port valve plunger, a parabolic plug type and a wide radio turned plug type are also available for exceptional control applications.

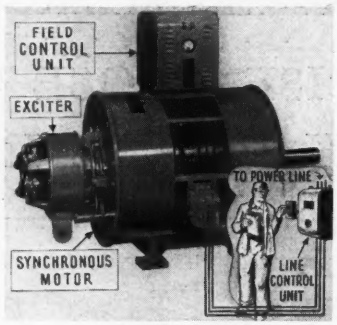


Accurate and efficient operation of the complete line of valves is provided by the Stabilflo floating power motor. Suspended construction of this motor eliminates the need for guides and antifriction bearings. The motor, which may be removed without in any way disturbing the motor adjustments or the relation between valve and motor, is protected from accidental injury by the low center of gravity and rugged connection to the valve. It has also been designed with sufficient excess power to enable it to meet all operating conditions.

Plungers of the Stabilflo valves are provided with top and bottom guides of polished stainless steel. The guiding surfaces are large in both diameter and depth, insuring freedom from excess wear. The spider construction of the guide supports prevents the deposit of sediment that would otherwise interfere with the operation of the valve.

High-Speed Synchronous Motor

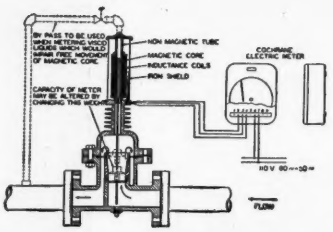
A NEW HIGH-SPEED synchronous motor of "packaged" construction has recently been developed by Electric Machinery Mfg. Co., Minneapolis, Minn. The packaged motor simplifies installation and wiring, reduces space requirements, and lowers first cost for the motor equipment. Wiring on the job for the packaged synchronous motor is the same as for a squirrel-cage induction motor. Need for a separate, panel-type control has been eliminated.



The packaged high-speed synchronous motor consists of: (1) a fabricated, all-steel motor of new, compact design, (2) an exciter, mounted on top of and V-belt driven by the motor, or direct-connected to the motor, and (3) a field-control unit, mounted on the motor, for automatically applying and removing excitation for the field winding of the synchronous motor. The exciter and field-control unit are wired to the motor at the factory. Thus, the only wiring required on the job is between the synchronous motor and the line control unit which can be an ordinary, wall-mounted across-the-line or compensator type induction motor starter. These machines are available up to 350 hp. at 1800 r.p.m.

Linameter

THE COCHRANE CORP., 17th Street and Allegheny Ave., Philadelphia, Pa., announces a new type of meter. The Linameter, as it is called, is of the area type,

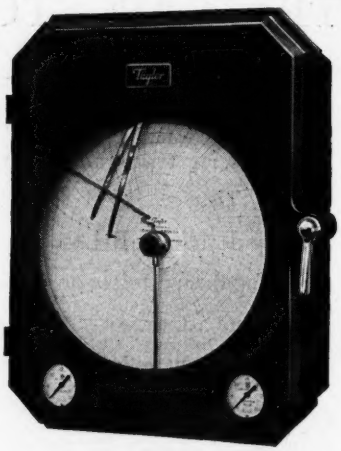


with meter body installed as an integral part of the pipe line, and containing a weighted disk positioned by the velocity of fluid through a tapered throat section in such a manner that the disk travel is directly proportional to flow rate. Attached to the weighted disk is a rod and iron core, the latter of which traverses the field of two reactance coils surrounding the pressure tight tube of the meter body. These coils form a reactance bridge when connected electrically to similar coils in the indicating, recording and integrating instrument and form the means of transmitting the measurement to any desired distance from the meter body.

It is made in different combinations of indicating, recording and integrating features to suit particular conditions and may be equipped with pressure and temperature elements to record on the same chart with flow. Styles are available for wall, column or flush panel mounting.

Fulscope Controllers

THE TAYLOR INSTRUMENT COS., Rochester, N. Y., have introduced a completely redesigned line of new Fulscope air-operated recording and indicating controllers for temperature, pressure, rate of flow, and liquid level. A supplementary control feature known as the Pre-Act makes control-valve corrections according to the rate of control-point deviation. The automatic reset feature,



which compensates for changes in load, is located in the instrument case and is fully adjustable over a much wider range than previously. The universal die-cast aluminum case is readily adaptable to face mounting or flush mounting. Simplified air system includes improved relay air valve with precisely drilled sapphire orifice; removable 18-8 stainless steel nozzle; inbuilt metal-disc auxiliary air filters supplement large external filter; air gages inside case; operates on 20-lb. sq. in. air supply.

Fine Workmanship

FIG. 150 BRONZE COMPOSITION DISC VALVE

FIG. 1708 WHITE STAR RENEWABLE SEAT AND DISC VALVE

• POWELL VALVES are noted for their fine workmanship and proper design for the particular jobs for which they are intended. Keep your operation costs at a minimum by selecting Powell Valves on your next installation. Our engineering staff will gladly assist you in your special valve problems.

WRITE US FOR FURTHER INFORMATION AND DETAILS

FIG. 375 BRONZE GATE VALVE

THE WM. POWELL COMPANY. CINCINNATI, OHIO

News from the Field

DENTON K. SWARTWOUT, 78, chairman of the board of the Swartwout Co., Cleveland, O., died suddenly March 24th of a heart attack at his home after having been in ill health several years. Mr. Swartwout founded the company about 1901 and was its president until four years ago. He was succeeded in the presidency by his son, Denton K., Jr. In addition to his son, he leaves his wife, Gertrude F., two grandsons, Kenyon and Charles Swartwout; four brothers and a sister.

Edgewater Station Extension

THE WISCONSIN Power and Light Co. has under contract a steam turbine generating unit being designed and constructed by Allis-Chalmers Mfg. Co. This unit, when complete, will be installed in the Wisconsin company's Edgewater Power Station located on Lake Michigan near Sheboygan. The contract, which includes a condenser and auxiliary equipment, is said to run to nearly $700,000.00. The new unit consists of a tandem compound steam turbine designed for 650 lb. steam pressure, 800 deg. F. total temperature and 29 in. of vacuum. It will be direct-connected to a 3600 r.p.m., 12,500-v. 30,000-kw. hydrogen-cooled generator. Sargent and Lundy of Chicago are the consulting engineers.

David C. Jones

DAVID C. JONES, Vice President and General Manager of The Lunkenheimer Co., Cincinnati, Ohio, died on March 11, after a brief illness. He was born in Cincinnati on November 14, 1876, and was in the employ of The Lunkenheimer Co. since 1894. He was prominently identified with industrial and banking activities in Cincinnati and also had served as president of the American Supply & Machinery Manufacturers' Association.

R. W. Sorensen Nominated for A. I. E. E. Presidency

ROYAL W. SORENSEN, Professor of Electrical Engineering and Head of the Department of Electrical Engineering at the California Institute of Technology at Pasadena. has been nominated for the office of President of The American Institute of Electrical Engineers for 1940.

Professor Sorensen has long been well known in the field of electrical engineering. Beginning his professional career in 1905 when he entered the test department of the General Electric Co., immediately after his graduation from the University of Colorado, he remained with General Electric until 1910. At that time he accepted the position of Associate Professor of Electrical Engineering at the Throop Polytechnic Institute, which later became known as the California Institute of Technology. In 1911 he was made professor and he has held this post, as head of the Department of Electrical Engineering, continuously since that time.

In addition he has been engaged in consulting practice in diversified fields. During 1913-17 he was engaged by the Pacific Light and Power Corporation in connection with their record-breaking 150 kv. Big Creek Transmission System, which is now a part of the Southern California Edison System. From 1917 until 1929 he was a Consulting Engineer for the U. S. Electrical Manufacturing Company in connection with induction motor design. In association with Dr. R. A. Millikan, he developed and patented a vacuum type of circuit breaker, and during 1929-30 he was engaged in special work on this device in the laboratories of the General Electric Company. Since 1931 he has served as a member of the Board of Consulting Engineers for the Metropolitan Water District of Southern California, which is building the Colorado River Aqueduct to Southern California. Professor Sorensen also developed, independently of the contemporary German investigators, the cascade or chain connection now regularly used for high voltage testing transformers, and applied it to the first 1,000.000 volt power-frequency high-voltage laboratory in the United States. erected at the California Institute of Technology in 1922-23.

Budget of $37,200,000 for Federal Power Projects

IN THE BUDGET now before Congress, a fund of $37,200,000 is included for the construction of projects now in progress under the direction of the Department of Interior, and the fund is generally expected to be approved. For the Boulder Canyon project, Boulder dam, Arizona-California-Nevada, an appropriation of $4,000,000 is being arranged for the fiscal year; All-American Canal system, California, $1,000,000; Central Valley project, California, $16,000,000 for power dams, hydroelectric generating station and other structures; Grand Coulee project, Grand Coulee dam, Columbia Basin project, Washington, $12,000,000; and Parker dam project, Arizona, where a hydroelectric generating plant is now in course of construction, $3,500,000. A fund of $700,000 is included for administrative expenses.

A fund of $2,800,000 is included in the budget for the War Department, to provide $2,000,000 as an appropriation for continuing the construction and installation of a hydroelectric power plant at Fort Peck, Mont., under the direction of the United States Engineer Office, Missouri River Division, Kansas City, Mo.; bids are scheduled to be asked at early date for the construction of substructure, penstocks and other work; an appropriation of $800,000 will be provided for the completion of power station and installation of six hydraulic turbine-generator units at the Bonneville project, Bonneville dam on the Columbia River, Bonneville, Ore., in charge of the United States Engineer Office at that point.

Philadelphia to Expend $18,000,000 for Water System Improvements

THE CITY COUNCIL, Philadelphia, Pa., has adopted an ordinance providing for a loan of $18,000,000 for expansion and improvements in the municipal water system, reducing by $2,000,000 the appropriation of $20,000,000 requested by Mayor Lamberton. The project will be up before citizens for ratification at the primary election April 23, and on approval, the loan will be underwritten at once so as to permit work to begin early in June. The project will be carried out by the Department of Public Works, City Hall, John H. Neeson, director, and will include pumping equipment for new stations and expansion in present such plants, power facilities for operation, pipe lines for extensions and replacements, service lines, meters and other miscellaneous work. It is estimated that a period of about 30 months will be required to complete the development.

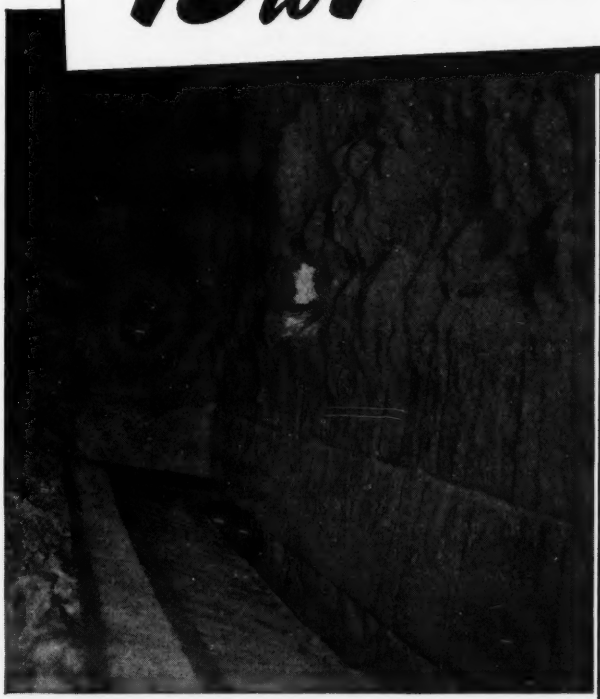
Northern New York Power Companies Plan Ten-Year $150,000,000 Expansion

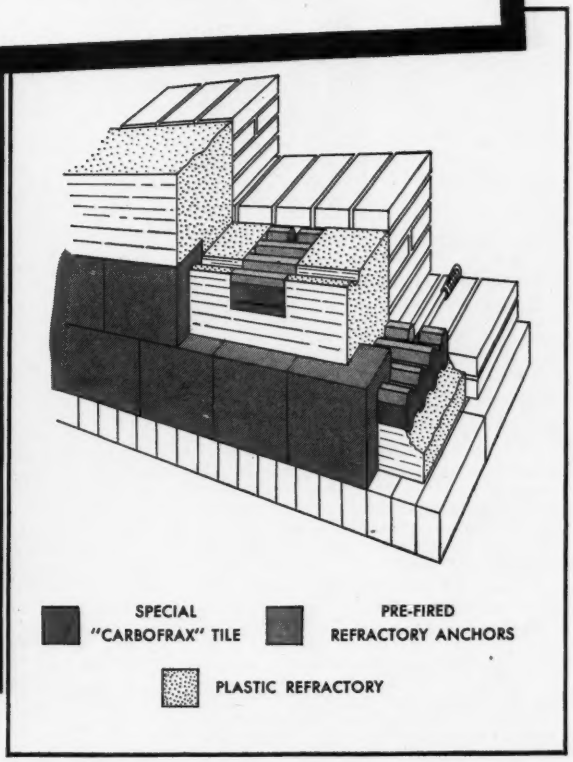
IN CONNECTION with a proposed consolidation of its five principal subsidiaries, the Niagara Hudson Power Corporation, Buffalo, N. Y., estimates that expansion and improvements in properties over a period of ten years will require a gross fund of $150,000,000 in such time or at least $15,000,000 a year. The work, as outlined in a petition for the consolidation, includes expansion in electric generating plants, both steam and hydroelectric; new transmission and distributing lines, power substations and switching stations, extensions in rural electric systems, with service facilities for additional consumers in cities, towns and rural districts in Northern New York. The initial step in the program is proposed to be carried out in 1940. The companies to be consolidated include the Buffalo & Niagara Electric Corp.; New York Power & Light Corp.; Niagara, Lockport & Ontario Power Co.; Lockport & Newfane Power & Water Supply Co., and Central New York Power Corp.

Toledo Edison to Expend $4,500,000 at Acme Station

THE TOLEDO EDISON CO., Toledo, Ohio, has plans under way for expansion in local Acme steam-electric generating station and will begin work on project at early date. Installation will include a 50,000-kw. turbine-generator unit and accessories, high-pressure boilers and auxiliary equipment, extensions in switchyard and additions to feeder lines from plant to city system, with power substation and switching facilities for distribution service. Entire project is estimated to cost close to $4,500,000, and is scheduled for completion early next year. This will be part of the 1940 expansion program of company, which has arranged financing in gross amount of $10,250,000, to be used for such purpose and for refunding certain outstanding obligations.

13 to 1 FOR "CARBOFRAX"





HERE'S a case where "Carbofrax" has already outlasted a high grade plastic refractory at the clinker line thirteen to one . . . and is still going strong! Good? Maybe you'd even call it perfect. We'll leave that up to you!

The ingeniously designed "Carbofrax" blocks immediately above the dump grate on the side wall of this boiler setting have been in service for three years and three months at exceptionally high ratings with very little sign of wear.

Not one cent has been spent for maintenance of this wall during that time, clinkering labor has been greatly reduced and efficiency of the boiler has been kept at a high point because clinker does not fuse to the "Carbofrax" and build out over the fire.

This record would be impressive by itself but when compared to this laundry owner's earlier experience it is outstanding. The high grade plastic refractory previously used gave excellent service in the upper walls, but in the zone just above the dump grates clinker adhesion was so severe that this area required relining every two or three months. Furthermore cleaning the clinker from the walls was an almost continuous operation.

. . .

Thus, "Carbofrax" has lasted thirteen times the life of the fireclay lining and looks good for many more months service. Perhaps your conditions are not so severe, but such a story indicates the savings that can be made in any installation with "Carbofrax".

Write our nearest branch office today for full information.

REFRACTORY PRODUCTS
CARBORUNDUM

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REG. U. S. PAT. OFF.

District Sales Branches: Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh. Agents: McConnell Sales and Engineering Corp., Birmingham, Ala.; Christy Fire Brick Company, St. Louis; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle; Denver Fireclay Co., El Paso, Texas.

(Carborundum and Carbofrax are registered trade-marks of The Carborundum Company)

Manufacturers' News

American Locomotive Co.

W. C. Dickerman

RECENT changes in the executive personnel announced by the American Locomotive Co. are as follows: William Carter Dickerman, Chairman of the Board; Duncan W. Frazer, President; Robert B. McColl, Vice President and Hugh M. Corrough, Manager of the Alco Products Division.

Mr. Dickerman became president of the American Locomotive Co. in 1929, which position he held until his recent appointment. At the present time he is a member of the executive committee and dirctor of a number of companies and societies.

Mr. Fraser having served the company in various capacities became Works Manager of the Montreal Works, and later Managing Director of the company. In 1920 he was appointed Vice President, retaining this position until his appointment as President.

Robert B. McColl became attached to the New York office of the American Locomotive Co. in 1922 and the following June was appointed Assistant Manager of the Schenectady Plant, and in 1925 Manager of the plant. At the time of his appointment he held the position as Vice President of the American Locomotive Co., Alco Products Division.

Mr. Corrough has been with Alco Products Division of the American Locomotive Co. since 1936 and served in the capacities of Chief Mechanical Engineer, Asistant Manager of Engineering and Manager-Engineering which position he held until his present appointment.

THE ELECTION of H. A. Feldbush as a Vice-President of the Worthington Pump and Machinery Corp. was announced recently by H. C. Beaver, President. Mr. Feldbush will make his headquarters at Holyoke, Mass., where he will have charge of operations of the corporation's Holyoke Works in the manufacture of air and refrigerating equipment. Feldbush was formerly general manager of the Carbondale Division of Worthington at its Harrison, N. J., Works, and in his new capacity will continue as an active member of the Carbondale Operating Committee.

ORIN B. COLDWELL, for 24 yr. Vice President of the Portland General Electric Co., retired March 1, 1940, as an active vice president. He will continue to serve the company in the capacity of a consulting engineer. He has been President of the Northwest Electric Light & Power Association and active in the committee work of the National Electric Light Association and the Edison Electric Institute. He is a Fellow of the American Institute of Electrical Engineers, and during the World War was active on the War Industries Board. He was born at Salem, Oregon, in 1875, moving to Portland in 1879.

R. R. ROBLEY has been named Assistant to the Vice President in the staff reorganization of the Portland General Electric Co. James H. Polhemus became President of the company and Franklin T. Griffith became Chairman of the Board of Directors. Fred G. Hodge became General Division Manager of the company, succeeding George E. Sullivan who became Vice President.

EDWARD S. PEROT has been elected President of the Crocker-Wheeler Electric Mfg. Co. Other officers elected were: Wallace K. Brown, Vice President; Ben D. Christian, Vice President; Edward C. Jones, Secretary, and Kenneth S. Murray, Asst. Treasurer.

STEPHEN C. MAY has succeeded M. L. Hough as General Sales Manager of the Darling Valve & Mfg. Co., Williamsport, Pa. He was formerly manager of industrial accounts for the Iron Fireman Co., and more recently eastern manager for G. S. Blakeslee & Co.

W. S. ARTHUR has joined the Cooper-Bessemer Corp. and will manage sales engineering activities in the districts served by the new sales office in St. Louis, Mo. In his position he will further sales of the company's gas engines, compressor units and Diesel engines.

F. H. WINKLEY, manager of the Lighting and Cable Division of the General Electric Co., retired from active duty March 1, according to an announcement by M. O. Troy, commercial Vice President.

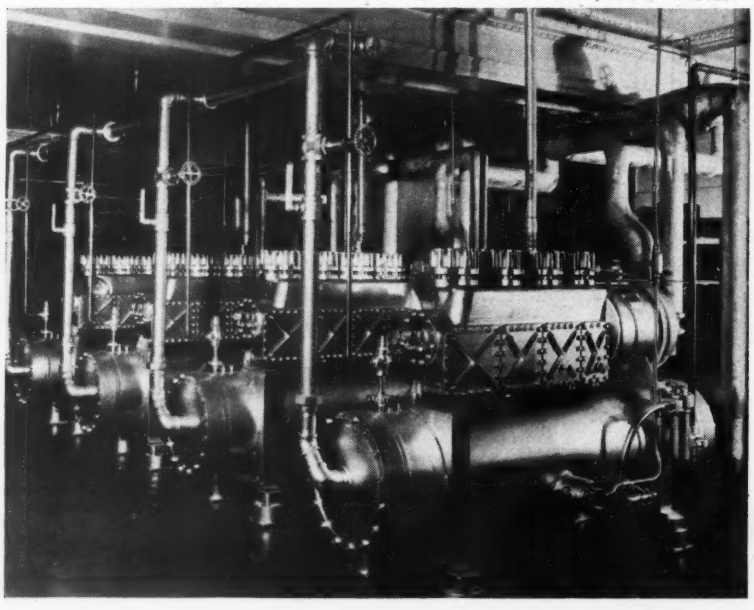
At the same time it was announced that two divisions would replace the one of which Mr. Winkley was head, with A. F. Dickerson appointed manager of the Lighting Division, and W. V. O'Brien manager of the Wire and Cable Division.

THE TIMKEN ROLLER BEARING CO. announces the appointment of Jay Irwin as Chicago District Manager of the Steel and Tube Division.

PRAT-DANIEL CORP. announces the appointment of Frank Howell Co., 318 American Bldg., Richmond, Va., as representative in that territory, handling Thermix Dust Collectors, fan stacks and air heaters.

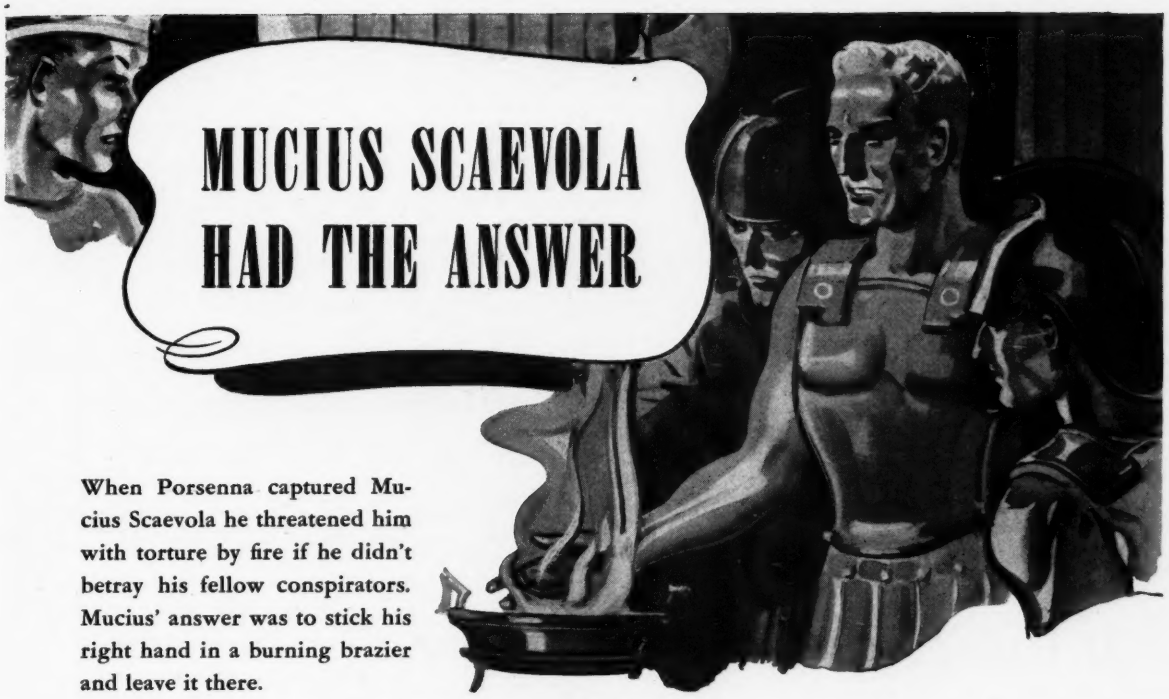
ROBERT W. LEA, vice president in charge of finance of Johns-Manville Corp. was elected a director at a meeting of the Board of Directors.

THE TIMKEN ROLLER BEARING CO. announces the appointment of William H. Richardson to the position of Assistant General Sales Manager. He has been associated with the company twenty-three years. E. H. Austin will succeed him as General Manager of the Service-sales Division. R. P. Proffitt has been appointed Chicago Division Manager.



Air Conditioning Costs Reduced 40%

OPERATING cost was reduced one-third to one-half when the Kroeschell Engineering Co. recently replaced the 15 year old CO_2 air conditioning plant at the State Lake Theatre, Chicago. In the new installation the first big modernization of its sort in the West, the four 40-ton Westinghouse condensing units total 160-hp., 200 sq. ft. of floor space, and weigh 10 tons. The previous two 100-ton CO_2 refrigerating machines required 250 hp., 1000 sq. ft. and weighed 83 tons without foundations. The new system operates in synchronism with the box office, units being automatically turned on and off to match the relative number of people in the theatre. Each of the hermetically sealed condensing machines has its individual evaporator unit to equalize loading and simplify operation. The machines work in conjunction with copper finned cooling coils and a bank of filters. The condensing units do not require foundations; in fact are so vibrationless that they are not even fastened to the floor.

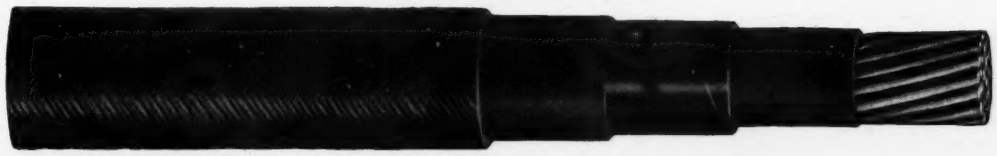


MUCIUS SCAEVOLA HAD THE ANSWER

When Porsenna captured Mucius Scaevola he threatened him with torture by fire if he didn't betray his fellow conspirators. Mucius' answer was to stick his right hand in a burning brazier and leave it there.

When a power plant engineer has a hot corner, a damp room, or an oily place for a cable installation, his answer should be—

DELTABESTON



YK-2250 Power Cable

YK-3159 Boiler Room Wire

YK-3160 Boiler Room Wire

Deltabeston Power Cables and Boiler Room Wires laugh at heat. You can bring electrical breakdowns from heat and moisture to a halt with these wires and cables. Fight heat and moisture with Deltabeston—the cable that can put up a real fight for you.

Asbestos insulation purified to an almost unbelievable extent. "Felted" right onto the conductor for a tight bond. A high-quality varnished cambric insulation to make it even better. Those are some of the unusual things you get when you buy and install G-E Deltabeston Power Cables and Boiler Room Wires.

Get Your Copy of the New Deltabeston Catalog. Tear Out the Coupon and Send it to Us.

Section Y-0854, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

Send me a new Deltabeston Catalog right away.

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GENERAL ELECTRIC

THE CORPORATE name of "The Whitlock Coil Pipe Company" has been changed to "The Whitlock Manufacturing Company." The management of the corporation, the character of its organization and its products remain unchanged.

JOE S. THOMPSON has been appointed District Sales Manager of the Chicago Office of The Babcock & Wilcox Tube Co.

THE HAYS CORP. annouces the appointment of Charles M. Chapman of Cincinnati as their representative covering southern Ohio and contiguous territory in Kentucky and Indiana.

THE CHESAPEAKE AND OHIO RAILWAY CO., Richmond, Va., announces the appointment of A. W. Thorson as Assistant Fuel Service Engineer, with headquarters in General Motors Building, Detroit, Mich.

UNDERGROUND STEAM CONSTRUCTION CO., Boston, Mass., subsidiary of E. B. Badger & Sons Co., announces the appointment of Charles E. Mayette to its sales engineering staff.

J. M. READ of New Bedford, Mass., has been named a director of Revere Copper and Brass, Inc.

CHAIN BELT CO. has announced the election of J. C. Merwin to the office of Treasurer in addition to that of Vice President, which he now holds, and the appointment of L. B. McKnight as Assistant to the Vice President.

THE DURALOY CO., Scottdale, Pa., announces the appointment of F. B. Cornell and C. H. Knappenberger as its agents for the state of Michigan. This new agency is known as The Duraloy Company of Detroit, with offices at 1124 Ford Building, Detroit, Mich.

JAMES W. COREY, since 1932 General Sales Manager of The Reliance Electric & Engineering Co., Cleveland, was elected Sales Vice President at a meeting of the company's directors, held March 21st.

E. KEELER CO. announces the appointment of O. H. Henschel, Milwaukee, Wis., as district representative for the sale of Keeler boilers in the State of Wisconsin.

For the Engineer's Library

Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

Heating, Ventilating and Air Conditioning

Climate Changers—Trane unit coolers and air conditioners are now grouped under a single classification, namely Climate Changers. Bulletin D303-2 containing 76 pages gives complete engineering data on the entire Trane line. The Trane Co.

Ventilating Equipment—A new 18-page bulletin FU-22 on air circulating and ventilating equipment, contains a full discussion of where and how to use this type of equipment for both cooling and ventilating purposes. In addition to the general discussion on air circulation and ventilation, the bulletin illustrates and describes the complete line of Wagner fans. Wagner Electric Corp.

Instruments

Instruments—A new 4-page bulletin entitled Increased Production Without Plant Expansion, illustrates and describes the Brown Steam Flow Meters. The Brown Instrument Co.

Mechanical Flow Meters—Catalog No. 2203 covers the complete line of mechanical flow meters, indicators, recorders and air-operated flow controllers. Operating advantages are described in detail. The Brown Instrument Co.

Coal Handling Equipment

Coal Crusher—Construction, operation and engineering data on Reversible Pennsylvanias are given in 4-page Bulletin 1030. Pennsylvania Crusher Co.

Stokers—Bulletin 203 gives engineering data, descriptions and specifications of the Canton Vulcan heavy duty industrial ramfeed stoker. The Lo-Set ramfeed stoker is described in bulletin 400. Canton Stoker Corp.

Automatic Coal Sampler—Bulletin No. P-6 1939 describes the Torsten automatic sampling system and gives a complete picture of the design and operation equipment used. The Thorsten Sampler Co.

Water Treatment

Water Treatment—A new 36-page pocket size booklet entitled Boiler Water Impurities and Their Control, by Roy C. Henszey, treats the subject thoroughly. It is divided into four parts and covers the following subjects: Boiler Water Troubles; Boiler Water Impurities; Water Analysis; and Control of Boiler Water. The Henszey Co.

Chemical Pumps and Proportioners—Self-contained, single and multiple unit high pressure chemical pumps and proportioners are described in an illustrated Bulletin 1039. Milton Roy.

Electrical Equipment

Transformer—Bulletin B 6043 illustrates and describes Chlorextol Transformers. Allis-Chalmers Mfg. Co.

Electrical Equipment — Bulletin GEA-1184D describes the A.C. magnetic motor-starting switch CR7006-D30B. Directional ground relays are described in Bulletin GEA-209A. General Electric Co.

Reliance Motor-Generator Sets, built in sizes up to 500 kw., are illustrated and described in Bulletin 502. Reliance Electric & Engineering Co.

Pumps and Compressors

Turbines — Geared turbines using high pressure steam have been substituted for Diesel engines to drive the dredging pump, cutter head, and other equipment of the dredge G. A. McWilliams. Full particulars of the changeover, with drawings and photographs, are given by Jean M. Allen, consulting engineer, who supervised both the original design and the conversion, in an article which is being distributed by the De Laval Steam Turbine Co.

Pumps—A bulletin announcing a new line of pulseless discharge Rotex pumps with helical gear rotors, in sizes under 3 in. for capacity requirements from 5 to 100 g.p.m. contains data, specifications and dimensions on all sizes of Rotex pumps from 1 up to 6 in. Quimby Pump Co.

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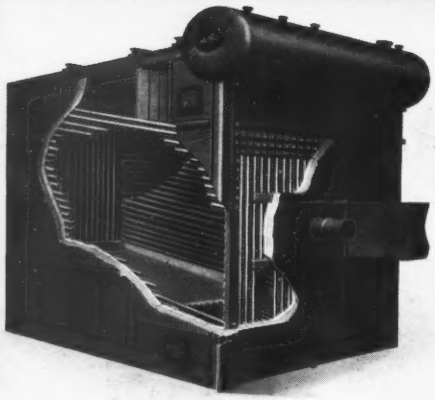
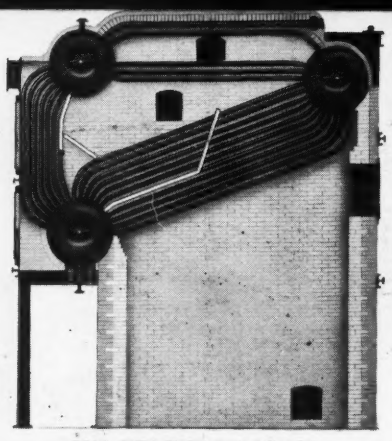
OF BUILDING STEAM GENERATING EQUIPMENT ONLY POINTS THE WAY TO NEW DEVELOPMENT AND FRESH ACHIEVEMENT. THOSE SUCCESSFUL YESTERDAYS INSPIRE US TO A FUTURE WORTHY OF OUR HERITAGE.

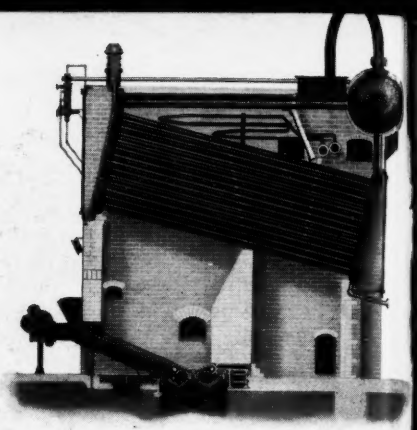
ERIE CITY IRON WORKS, ERIE, PA.



ERIE CITY INTERNALLY FIRED CROSS DRUM



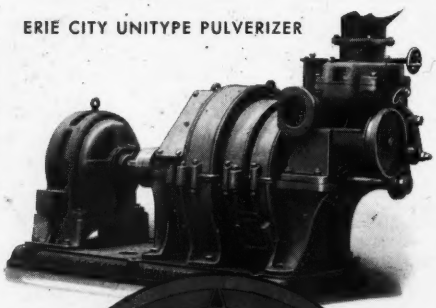
ERIE CITY TYPE "C" BOILER

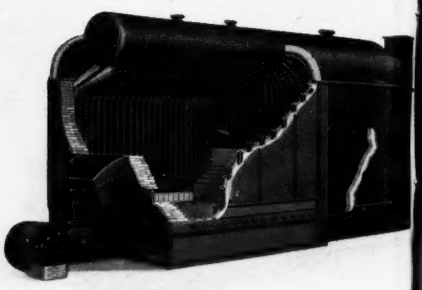


ERIE CITY CROSS DRUM (BOX HEADER)

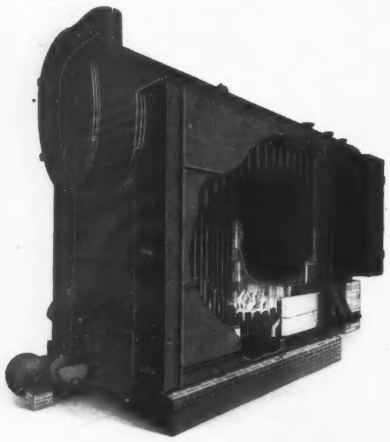
ERIE CITY CROSS DRUM (SECTIONAL HEADER)

ERIE CITY UNITYPE PULVERIZER





ERIE CITY "VL" BOILER



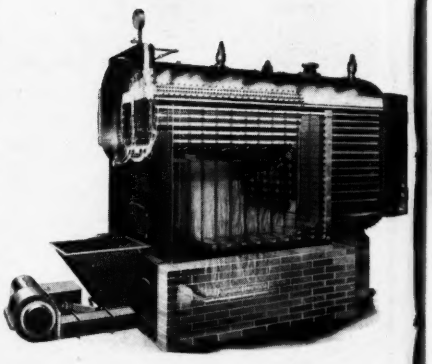
ERIE CITY WATER WALL ECONOMIC

ERIE CITY WELDED H. R. T. BOILER

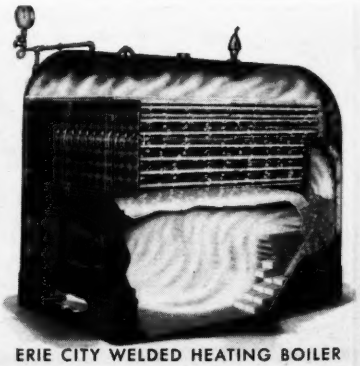
ERIE CITY IRON WORKS A CENTURY OF BOILER BUILDING 1840 ERIE PA. 1940

Today

These illustrations indicate the wide selection of Erie City boiler designs to meet steam generating requirements today. A modern plant and a wide background of experience are ready to adapt some one of these units to your needs.



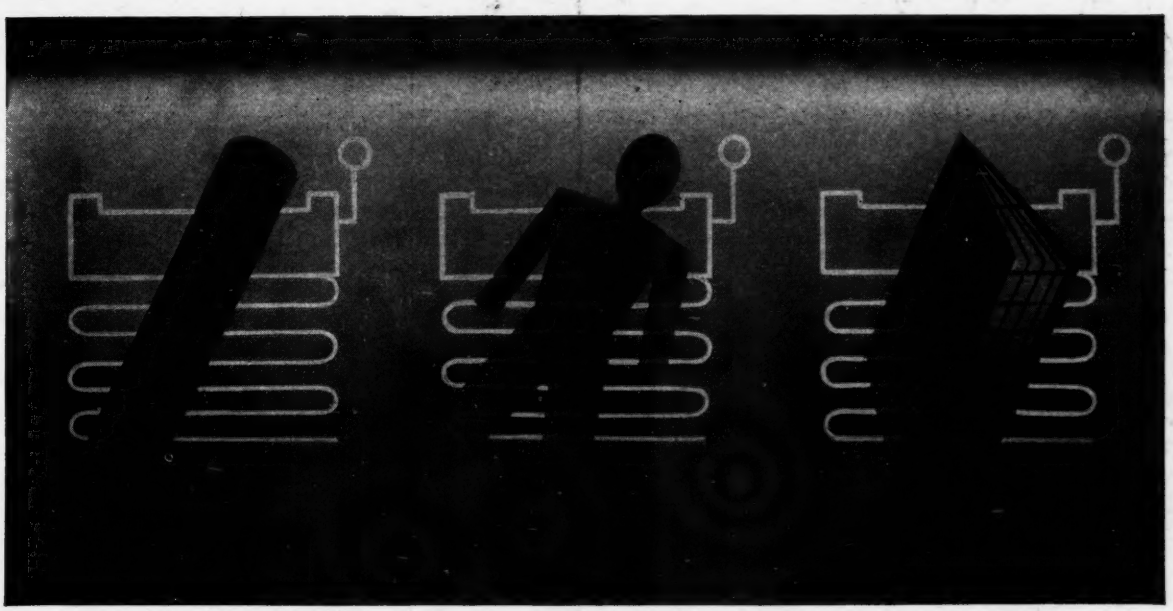
ERIE CITY ECONOMIC BOILER



ERIE CITY WELDED HEATING BOILER

ERIE CITY IRON WORKS · ERIE, PA.

Since 1840



HERE'S A 3-WAY SERVICE TO LESSEN YOUR CONDENSER TUBE PROBLEMS

There are three major services you receive, at no extra cost, with every pound of condenser or heat exchanger tube you buy from Scovill. Here are the three aids you get, each contributing to trouble-free service:

SERVICE IN METALS—consisting, first, of laboratory development of new alloys fitted for better and longer service under particular operating conditions. For example, a Scovill Copper Nickel Alloy has been found to give more economical service under certain conditions of operation even though the per pound cost of the Copper Nickel is considerably higher than the Admiralty Metal previously used in many such cases. Then there's the constant vigilance of inspection of raw materials, and of finished tubes. You can expect uniformly high quality on every shipment from Scovill.

SERVICE IN MEN — Scovill's engineering representatives who also serve you in two ways. When they first contact you, they study the conditions under which you operate, and carefully prescribe the alloy that will serve you longest, with least trouble. Then, after the tubes are installed, they don't forget you—they maintain a field staff to check on how the tubes are operating in service. If anything is wrong, they go to work to find and root out the trouble. A case in point — a customer thought his troubles were due to use of the wrong alloy. Scovill engineering representatives helped him cure the troubles by merely using a different method of installation.

SERVICE IN MANUALS—new reservoirs of knowledge about condenser and heat exchanger tubes have accumulated since the earlier editions of Scovill's manuals were published. We have just published a new edition of the 68-page "Condenser Tube Booklet." It is free for the asking. Send today for your copy. Address 17 Mill Street, Waterbury, Connecticut.

for any of these services . . .
***think of* SCOVILL, "MASTERS OF METAL"**

Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL CONDENSER TUBES
one product . . . three services

SCOVILL MANUFACTURING COMPANY
17 Mill Street, Waterbury, Connecticut

Please send me the new, revised "Condenser Tube Booklet."

Name.....

Company.....

Street.....

City.....*State*.....

"You can bank on FAIRBANKS"

VALVE INSPECTION

that guarantees better service

Sterling quality in all valves produced by Fairbanks results from the use of the highest grade materials constantly tested for the most desirable physical and chemical properties, close control of the "mix" of elements going into castings and the use of modern foundry equipment and high precision-production tools.

All parts are carefully inspected during machining and must pass the closest tolerance before acceptance for assembly. Inspection instruments are frequently checked for accuracy against master gauges to insure maintenance of precision standards.

Every Fairbanks Valve, regardless of size or rating, is given a hydrostatic test for more than double the rated pressure. For oil and gas service Fairbanks Valves must pass a special air test to insure tightness under the most exacting conditions.

Fairbanks Valves—in more than 3,000 different sizes and types—are available in pressures from 125 to 350 lbs., in brass and iron—a complete line.

Write for catalog No. 21.

THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

399 Lafayette St., New York, N. Y.

Boston, Pittsburgh—Distributors in Principal Cities

Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks *Standard and* Renewable **Valves**

Air Compressor — Bulletin H-620-B22 describes the Worthington Balanced-Angle 2-cylinder air compressor. Size and capacities are included in the bulletin. Worthington Pump & Machinery Corp.

Belting

Leather Belting—A new 24-page spiral bound bulletin gives a complete treatise on this subject. Tension welded leather belting is described in detail. Engineering Service data is included in the bulletin. Chicago Belting Co.

Belting—Duplex, a new leather link belt, is illustrated and described in a new booklet including price lists and tables. Alexander Brothers.

V-Belts—A revised catalog section, No. 151, introducing new horsepower ratings for multiple V-belt drives based on the new formula developed by Robert F. Vogt and recently adopted by the industry provides engineering information on selection of size of belt for horsepower rating, speed, center distances and sheave diameters. Allis-Chalmers Mfg. Co.

Materials

Creep Stress Data—Relative Creep Stress Data on Croloys 2 and 2¼ and other materials in the same range in the high-temperature tubing field are available on a handy letter-size card, Technical Data Card No. 4. The data are arranged in the form of a chart so that the relative creep strength of each material can be seen at a glance. The Babcock & Wilcox Tube Co.

Metal—A useful publication, Application Data No. 6, presents briefly-summarized data relating to the application of B&W Croloys and other tubular material for high temperature service. Data are given on fifteen different materials, representing a complete range for almost any high-temperature tube application. The Babcock & Wilcox Tube Co.

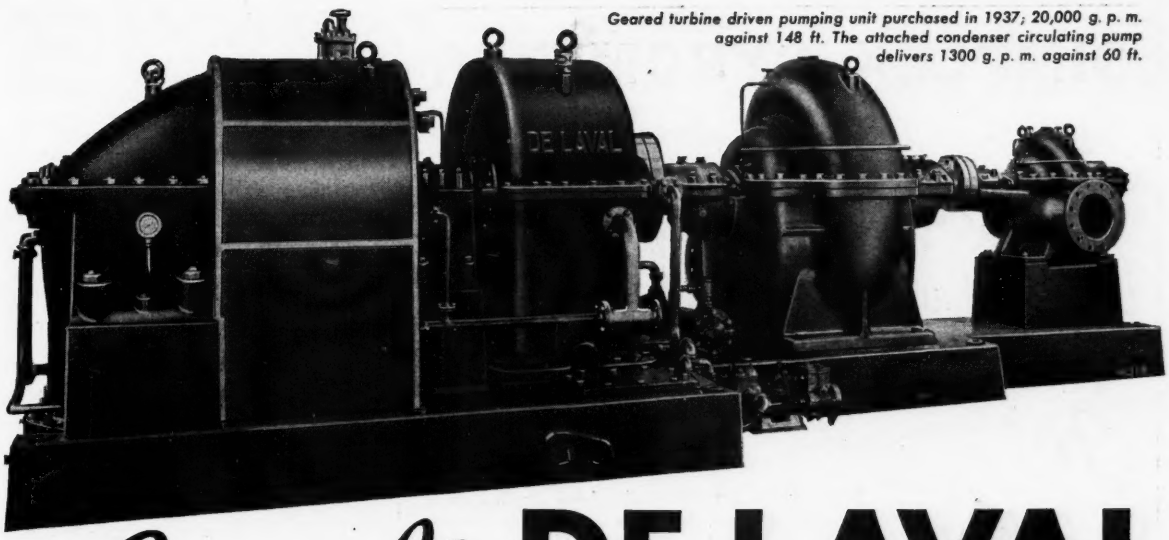
Insulation—Volume FES 40 containing 24 pages illustrates and describes Schundler Insulations, including pipe coverings, blocks, insulating cements, lagging, blankets. F. E. Schundler & Co., Inc.

Vibration Control—A new 8-page Treatise entitled Korfund Vibration Control for Concrete Foundations covers the subject thoroughly with text, illustrations and photographs. The Korfund Co., Inc.

Valves and Piping

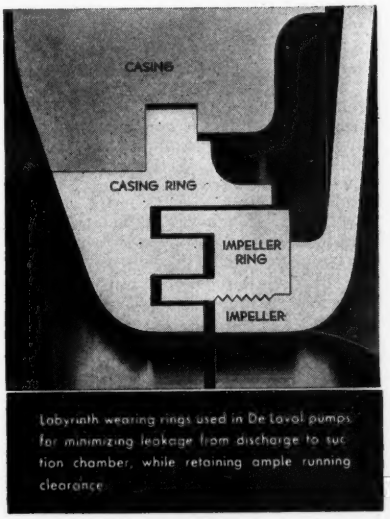
Stabilflo Valves — An illustrated folder D.M.F. 789 describes this rugged, yet extremely accurate, valve for use in process control. A cut-away view of one of these valves, shows the new guided plunger construction. Accompanying text describes three available types of plungers. The Foxboro Co.

Steam Trap—Bulletin T-1735 contains 16 pages and gives a complete description of Yarway impulse steam trap. Construction, operation and applications are given in detail. Yarnall-Waring Co.



Geared turbine driven pumping unit purchased in 1937; 20,000 g. p. m. against 148 ft. The attached condenser circulating pump delivers 1300 g. p. m. against 60 ft.

Consult DE LAVAL
FOR ADVICE ON PUMPING



Labyrinth wearing rings used in De Laval pumps for minimizing leakage from discharge to suction chamber, while retaining ample running clearance.

State your pumping requirements so that we may send you Catalog P-3214.

DURING the past **TWENTY YEARS** a large industrial concern in the Middle West has bought approximately

50 DE LAVAL UNITS

in part as follows:

1919 — Motor driven pumps; 10,500 g.p.m. against 10 ft., 150 g.p.m. against 30 ft., and 1100 g.p.m. against 50 ft.

Turbine driven pumps; two for 4900 g.p.m. against 334 ft., two for 950 g.p.m. against 50 ft., two of 3000 g.p.m. against 231 ft., and two geared units for 10,000 g.p.m. against 68 ft.

1920 — Two geared turbine driven generators; 500 KW each.

1925 — Six motor driven 8 in. pumps.

1926 — Two pumps for 1800 g.p.m. against 290 ft., one motor driven and one with dual drive, and three 5000 g.p.m. pumps against 173 ft., two motor driven and one with dual drive.

1927 — 10 in. turbine driven pump.

1928 — **1929** — **1930** and **1931** — A number of small motor driven pumps.

1931 — Geared turbine driven pump; 7 m.g.d. against 145 ft.

1934 — Motor driven pump, 7000 g.p.m. against 90 ft.

1937 — The geared turbine driven pump shown herewith; 20,000 g. p. m. against 148 ft.

1938 — A 4 in. boiler feed pump.

Repeat orders imply satisfactory service and sound engineering advice. In fact, one of the customer's officers, who was Superintendent of one of the plants for 18 years, remarked:

"I have yet to receive poor advice from a De Laval man."

DE LAVAL *Steam Turbine Co.*
TRENTON, N. J.

MANUFACTURERS OF TURBINES . . . STEAM, HYDRAULIC; PUMPS . . . CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING; CENTRIFUGAL BLOWERS and COMPRESSORS; GEARS . . . WORM, HELICAL and FLEXIBLE COUPLINGS

SIMPLEX GYROMETER

An Inexpensive New Flow Meter For ALL Fluids

IN balancing a differential head applied to a diaphragm unit by means of gyroscopic couple forces, the Simplex Gyrometer insures accurate, straight-line totalization of any fluid flow.

The Simplex Gyrometer can be used with any type of primary pressure reducing device (orifice, venturi tube, nozzle, pitot) in any size of main to measure fluids varying from water and air to steam, gases and corrosive liquors.

Let us show you how this inexpensive and reliable unit will help you in solving your metering problems.

WRITE for FREE BULLETIN

SIMPLEX VALVE & METER CO.
6790 Upland St., Philadelphia, Pa.

PLENTY OF
PULLING POWER
with Safety!

Hidden nuts are hard and often hazardous to turn with ordinary wrench equipment. That's why this Snap-on Socket Set works a 24-hour shift in many plants where wheels must be kept turning and workmen earning.

These slenderized sockets slide in where other types of tools won't go, cling to the nut with an "all-around", slipless grip. Snap-on ratchets deliver full leverage with only 18° handle movement—fit the socket without "play", won't "let go" until you're through. 2300 Snap-on tools offer you a wide choice for both production and maintenance.

No. 477 Master Mech Set
Includes the complete range of double-broached hexagon socket sizes from ¼" to 1⅝"—to fit SAE sizes ¼" to 1⅛", USS nuts ⅛" to 1", USS Cap screws from ⅛" to 1¼". 28 sockets plus every possible handle hook up from midget sliding bar to the heavy duty ratchet illustrated.

Snap-on Wrenches
The Best Tools are the Safest Tools

SNAP-ON TOOLS CORPORATION
Dept. PPE-4 Kenosha, Wisconsin

Valves—An entirely new Consolidated Oil & Gas Relief Valve catalog 1600 has just been issued listing oil and gas relief valves only and contains detailed pages of capacity tables, over-pressure factor curves and valve selection data, explains in detail the Consolidated feature, the Self-cleaning outside bevel seat which is standard on all Consolidated oil relief valves. Consolidated Safety Valve Division of Manning, Maxwell & Moore, Inc.

Iron Pipe Coils—This illustrated catalog on coils, manifolds, ammonia fittings and similar equipment completely covers this particular line of equipment. Men interested will find this catalog very helpful when selecting this equipment. Rempe Co.

Gate Valves—Screw and flanged end drop forged steel gate valves of standard and new types are shown in a new bulletin giving complete data on 12 different types. Henry Vogt Machine Co., Inc.

Piping—Pipe hangers, radiator hangers, concrete inserts and pipe covering protection saddles are illustrated in a new 8-page circular giving prices and dimensions. Crawford Co.

Flexible Metal Hose—Bulletin 20-B, illustrates and describes flexible metallic hose of seamless construction, which is made in bronze and steel, furnished in various sizes and lengths. Recommendations and applications are given in the bulletin. Atlantic Metal Hose Co., Inc.

Miscellaneous

Industrial Research and Changing Technology is the title of a report which supplies the statistical data on industrial research in this country since 1920, based on several surveys of industrial research laboratories made by the National Research Council during the period from 1920 to 1938. Industrial distribution of the activities are analyzed and their concentration within industries in relation to types of problems to which research is directed is discussed. Works Projects Administration.

Stacks—An article from Steel entitled Rebuilding Stacks has been reprinted by and may be had on request to The Atlas Lumnite Cement Co.

Cooling Tower—Bulletin 602 containing 24-pages entitled Dollars and Sense of Industrial Cooling water illustrates and describes the Double-Flow induced draft cooling tower. The story of the development of this product since its development in 1937 is also included in the bulletin. The Marley Co.

Directory—Known as the Buyers' Guide and Industrial Directory of Chicago, this new volume, the fifth compiled by the Association since 1936, lists the output of more than 8000 Chicago companies in all of its almost countless categories. The Chicago Association of Commerce.

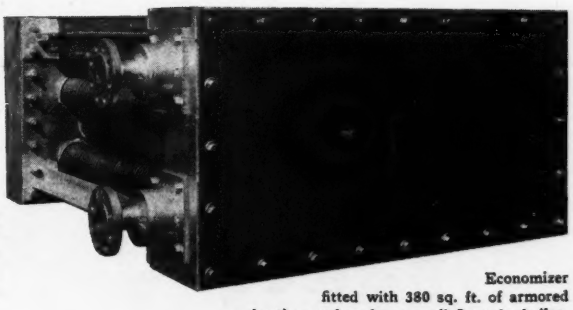
Wrenches—Five new single sheet publications descriptive of the CP365-R and 375-R Reversible Wrenches. Sizes and specifications are included in the literature. Chicago Pneumatic Tool Co.

Spaders—Spaders and Trench Diggers are illustrated and fully described in the new 4-page Bulletin 87-K. Sullivan Machinery Co.

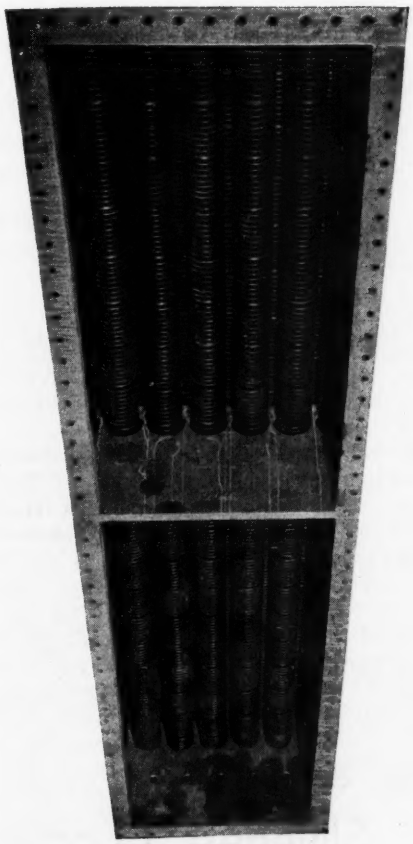
ECONOMIZERS

—six times the heat absorbing area of bare tubes

—the strength of steel with the corrosion resistance of cast iron



Economizer fitted with 380 sq. ft. of armored heating surface for a small fire-tube boiler.



View from below looking upward into an extended surface economizer.

Cast iron extended surface armored construction

Increases boiler capacity 8 to 10%

Increases efficiency 8 to 10%

Easily installed

Minimum maintenance
(less than 1% per year average)

FOSTER WHEELER CORPORATION, 165 Broadway, New York, N. Y.

FOSTER FW WHEELER

YOUR DOLLAR GOES FARTHER

on DART'S True Ball Joint

Use a Dart Union once, twice, time and again. Each time you reinstall it, *cost-per-tight-joint* goes down. That's the whole story of Dart economy. Plus, of course, the fact that Dart's ***repeated use*** is built on two bronze seats ground to a true ball joint that stays true to form in tough service—air-refined malleable iron bodies and nuts that resist stretch—extra "heft" that prevents damage from pipe strains and wrench abuse. It will pay you well to send for a Dart to try—free.

DART
UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

Trends in Turbine Generator Units

ACCORDING to an announcement by C. S. Coggeshall, manager of the General Electric Company's turbine division, turbine-generators ordered from this company for utility and municipal power plants in the United States since January 1, 1939, in ratings of 10,000 kw. and higher exceeded the 1,000,000-kw. mark in the 14 months ending February 29.

The 14-months' business equals the total of domestic utility and municipal turbine orders placed with the company during 1937 and 1938, and is within approximately 200,000 kw. of the machines ordered in 1929 in ratings of 10,000 kw. and higher.

An analysis of the orders comprising the 1,000,000 kw. total indicates a definite trend to higher temperatures and pressures and the use of hydrogen-cooling in power generating equipment.

In terms of kilowatt, 85 per cent of the total capacity ordered will use initial steam pressures of 800 lb. and above, with more than 50 per cent in the 1200 lb. range.

Similarly, 85 per cent of the 1,000,000 kw. will use initial steam temperatures of 900 deg. F. and above. Sixty per cent will be in the 900 deg. F. to 925 deg. F. range, and the other 25 per cent will be in the 950 deg. F. and above temperature class.

Average capacity of the higher temperature and pressure machines ordered is approximately double the average capacity of the turbines ordered in the lower ranges.

Eighty per cent of the 1,000,000 kw. will be produced by generators cooled by hydrogen instead of air. That hydrogen cooling is considered most economical for larger-sized machines is evidenced by the average capacity of the units to be so cooled —43,700 kw. The average capacity of the air-cooled machines ordered is 28,900 kw.

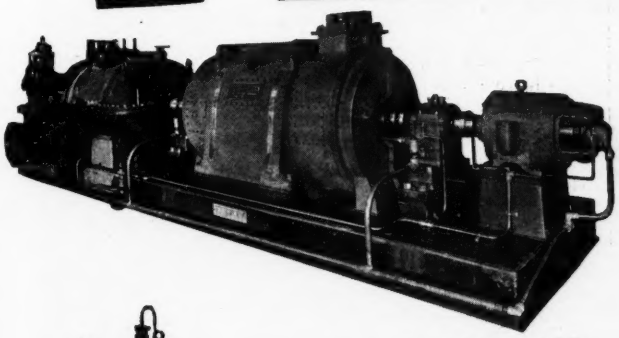
Two-thirds of the total capacity is made up of 3600 r.p.m. turbines, averaging 36,800 kw. per unit. Average capacity of the 1800 r.p.m. machines is 62,800 kw.

Dustless and Sliverless Copper

AFTER a ten-year research and development program the announcement of the perfection of a new type of copper has come from the Phelps Dodge Copper Products Corp. The new copper, known as "PDCP," was created to meet the need of the electrical industry for a copper of superior characteristics. Greater conducting power, ductility, fatigue resistance and surface quality are the outstanding characteristics of this modernized metal, designed for dependable performance under the present day demand for high speeds and less space.

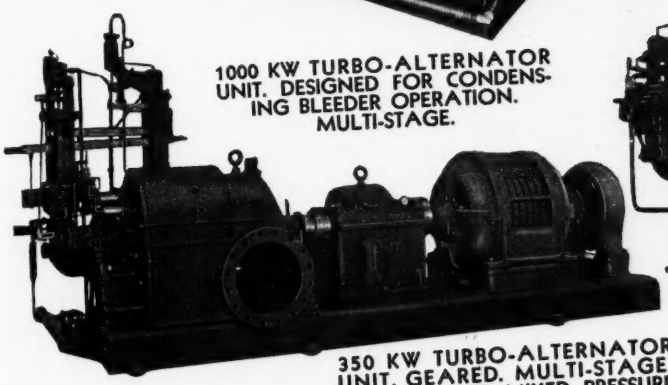
Continued on Page 130

TERRY

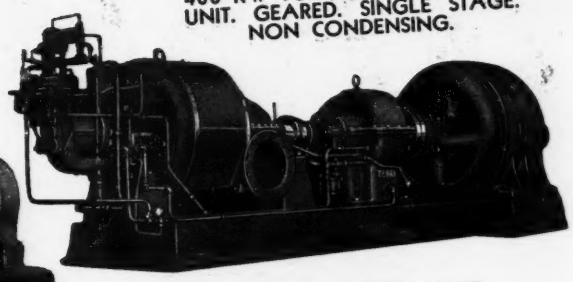


1000 KW TURBO-ALTERNATOR UNIT. DESIGNED FOR CONDENSING BLEEDER OPERATION. MULTI-STAGE.

400 KW TURBO-ALTERNATOR UNIT. GEARED. SINGLE STAGE. NON CONDENSING.



350 KW TURBO-ALTERNATOR UNIT. GEARED. MULTI-STAGE. DESIGNED FOR MIXED PRESSURE BLEEDER OPERATION.



500 KW TURBO-ALTERNATOR UNIT. GEARED. MULTI-STAGE. NON CONDENSING.

For Turbo-Generator Units

Terry Generator Units are individually designed and proportioned so as to operate most efficiently under the customer's conditions. They are the result of over 40 years of successful experience in the manufacture of steam turbines.

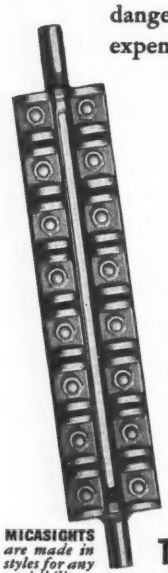
They are available in high, low, mixed and bleeder designs in all capacities up to 1000 KW.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

T-1136

New Water Gage Safety
• with *Unbreakable* •
MICASIGHT INSERTS

YOUR high pressure boilers need this pressure-defying MICASIGHT to make safe the important job of watching water levels. You're money ahead when you remove danger of flying glass — save the bother and expense of constantly renewing gage glasses.



Mica *bends,* but doesn't shatter. Even the thin sheets you see above resist the highest pressure you'll use. The Reliance forged steel body clamps mica securely, leak proof. Easily replaced if dirty after long use. Can be illuminated for bright sharp reading high on the drum.

Micasight Inserts install quickly in your present gage valves or in long-lasting Reliance Forged Steel Valves. Install this praise-winning safety gage as hundreds of progressive engineers have done. . . Write today for MICASIGHT Bulletin.

MICASIGHTS *are made in styles for any visibility measurement*

The Reliance Gauge Column Co.
5902 Carnegie Avenue • Cleveland, Ohio

Reliance
Boiler Safety Devices since 1884

Under a patented process, the improved metal is made without melting from electrolytic cathode copper, which is plastically converted by tremendous pressure in a reducing atmosphere at elevated temperature into smooth, dense copper bar, rod, strip or other desired commercial shapes.

Basically of the oxygen free type, it is not melted subsequent to the electrolytic purification process. Hence, the intrinsic purity of electrolytic cathode copper is not only retained, but is greatly enhanced at the high temperature of the reducing gas used in the process.

One of the principal difficulties of copper windings in motors and transformers is the existence of surface imperfections in the copper, which by vibration and magnetic stress eventually penetrate the insulation and cause failure by short circuits. These imperfections may originate in defects arising in the casting process. In addition, slivers and oxides are developed during the process of hot-rolling the cast copper bars into rods, and are more or less inherent in the hot-rolling process. The new method eliminates not only the casting process, but also hot-rolling. It has, in consequence, made possible the production of a sliverless and dustless copper surface heretofore attainable only in the laboratory.

Summer Graduate Courses at Armour

ARMOUR INSTITUTE of Technology, Chicago, according to the announcement made by Dr. L. E. Grinter, vice-president and dean of the graduate division, will conduct a three-term Summer Graduate Institute for engineers, professional men, industrialists, and educators in engineering and science beginning with the summer of 1940. It is planned, according to Dr. Grinter, who is in charge of the Summer Institute beginning with this year, to invite scientists of great distinction to lecture each summer on modern developments in engineering and science.

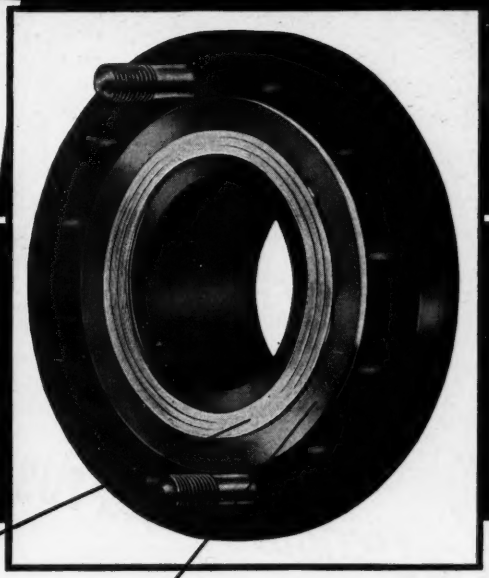
The faculty of the Summer Institute for 1940 includes, in addition to prominent men from the staff of Armour Institute, the following visiting professors: Ralph M. Barnes, Iowa State University; John R. Baylis, City of Chicago; Barnett F. Dodge, Yale University; William R. Everitt, Ohio State University; C. C. Furnas, Yale University; E. Hurwitz, Chicago Sanitary District; Lydik S. Jacobsen, Stanford University; G. B. Karelitz, Columbia University; Gabriel Kron, General Electric Company; Charles O. Mackey, Cornell University; Floyd W. Mohlman, Chicago Sanitary District; J. C. Morrell, Universal Oil Products; H. C. Taylor, Western Electric Company; Stephen P. Timoshenko, Stanford University; Frank C. Vilbrandt, Virginia Polytechnic Institute; and John I. Yellott, Stevens Institute of Technology (Mr. Yellott in September, 1940, will become head of Mechanical Engineering at Armour College of Engineering of Illinois Institute of Technology.)

Continued on Page 132

For high-pressure flanged joints

FLEXITALLIC STYLE C-G GASKETS

Applicable to Raised Face, Smooth Face, Van Stone or Cranelap Fittings.



Safety and springiness contributed by a spiral wound member.

Solid metal member acts as a compression gauge and assures correct bonding load.

Construction of each spiral wound member is governed by design of fittings and by the required bonding load for working pressure and temperature.

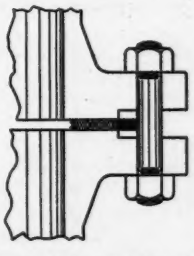
When the spiral wound member is compressed so that the flanges bear on the solid ring, then the correct bonding load is on the gasket without over-stress of bolts or flanges.

For 28 years, Flexitallic Gasket Company has anticipated demands by industry for spiral-wound gaskets capable of holding increased pressures and temperatures.

The greatest improvement is the Flexitallic C-G Gasket. Its outside metal ring acts as a compression gauge, so that you know when the gasket is correctly compressed. This ring also provides complete confinement of the gasket member. Therefore, this gasket is absolutely safe.

You can replace the gasket proper using the compression ring innumerable times. This reduces your replacement cost. The gasket is easy to install, is safe, foolproof and economical.

Flexitallic Gaskets are constructed according to the engineering requirements of the individual installation.



Diagrammatic section of a CG Gasket with typical Raised Face fittings showing the flanges compressed to the thickness of the solid metal member.

"Flexitallic" Reg. U.S. Pat. Office

As the first step in the satisfactory solution of your gasketing problems, write on your letterhead to Dept. A for our C-G bulletin, or, better still, detail to us your gasket troubles.

Patents are pending for the Style C-G Gasket.

FLEXITALLIC GASKET CO., 8th and Bailey Streets, Camden, N. J.

Originators of Spiral Wound Construction

Renewable HI-LAG FUSES

Note these important advantages you get when you specify WARE HI-LAG FUSES:

1 HIGHER LAG ON STARTING LOADS! Exceptionally high time lag eliminates blow-outs caused by starting motors and momentary surges.

2 GREATER STRENGTH AND DURABILITY! New **double-bridge**, self-aligned knife-blade assembly insures extra strength and longer life.

3 SIMPLIFIED CONSTRUCTION! New **double-bridge** assembly easier to renew correctly than to overload. Remove only one end of casing to renew fuse. Assembly may be inserted either end first.

4 SPRING TENSION CONTACT! Greater contact surface. Links will not blow because of inadequate or faulty contacts.

5 MAXIMUM PROTECTION—MINIMUM COST! Underwriters approved. 100% protection to your circuits. Construction insures utmost economy of renewal expense. Saving of lost time will more than pay for the fuses. START ECONOMIZING!

Write for our TRIAL TEST OFFER, Sizes and Prices.

WARE BROTHERS
4500 W. LAKE ST., CHICAGO

The faculty members of Armour Institute who will cooperate in this summer program include: Paul L. Copeland, Lloyd H. Donnell, H. P. Dutton, Rolf Eliassen, Lester R. Ford, L. E. Grinter, Vasili I. Komarewsky, Max Jacob, Harry MacCormack, Joseph Marin, Myril B. Reed, Hans Reissner, Max Sadowsky.

This Summer Institute is divided into seven separate and distinct divisions and the program of specialized classes have been arranged to provide an opportunity for graduate work on the highest possible plane. These divisions include Advanced Mechanics, Chemical Engineering and Chemistry, Civil and Sanitary Engineering, Electrical Engineering and Physics, Mechanical Engineering, Industrial Engineering and Applied Mathematics.

Cable Operation in 1938

A REPORT of the Transmission and Distribution Committee of the Edison Electric Institute, published January, 1940, contains a great deal of data of value to those interested in high voltage cable operation.

The 55 companies which contributed data for this report had 395 miles of 1938 vintage high voltage paper-insulated cable operating on their systems at the end of the year.

Trouble rate for all high voltage cable of 6.3 was the lowest yet reported since the Committee started gathering removal data in 1934. The failure rate of 4.7 is the lowest yet reported. For the third consecutive year there has been a steady decrease in the test failure rate to a value of 0.8, the lowest value noted since 1930. The trouble rate for paper-insulated cable was 6.2, a decrease of 11 per cent from last year's value. The failure rate decreased 7.1 per cent and the removal rate decreased 22 per cent as compared with the 1937 values.

For all high voltage joints, the trouble rate was 1.7. This rate is composed of a service failure rate of 0.8, a test failure rate of 0.3, and a removal rate of 0.7. The combined service and test failure rate is 14 per cent higher than the corresponding 1937 value. The removal rate, however, is 34 per cent lower.

For potheads, integral with apparatus, the trouble rate was 0.6, the failure rate being 0.5 and the removal rate 0.1. Potheads installed outdoors had a trouble rate of 14, the failure rate being 5.3 and the removal rate 8.5. Potheads installed indoors had a trouble rate of 0.1, the failure rate being 0.7 and removal rate 0.3. These three groups of potheads had marked decreases in the 1938 trouble rates when compared with those of 1937. The decrease in the trouble rate for potheads integral with apparatus was 83 per cent, for potheads installed outdoors 12 per cent, and for potheads installed indoors 68 per cent.

Approximately 70 per cent of the cable and joints covered in this report were subjected to high potential tests. Unlike the data of last year the cable failure rate in service on tested cable was 16 per cent higher than for untested cable. The joint failure rate in service, as in past years, on tested cable was 13 per cent

Continued on Page 134

ACCURATE COMBUSTION CONTROL

. . . . . THIS SIMPLE PURCHASING PLAN GIVES YOU AN IMMEDIATE START ON THE MONEY SAVING BENEFITS OF AUTOMATIC COMBUSTION CONTROL

For $98.00 INITIAL OUTLAY

This purchase plan was devised to make it easy and convenient for you to get the many benefits of modern Automatic Combustion Control as described in this advertisement, without making a large initial expenditure. There is no finer equipment made. In installations made on this plan you get precisely the same control units that we furnish on the most elaborate kind of job, and for the largest kind of boilers.

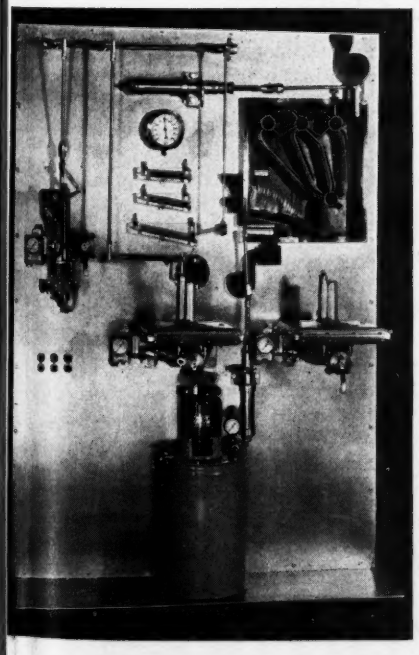
YOU ADD THE REST OF THE SYSTEM LATER AND It is NOT expensive

YOU CAN GET THIS FURNACE DRAFT CONTROLLER FOR ONLY $98.00

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from over-fire draft, regulating the boiler up-take damper, to maintain a constant draft in the combustion chamber. Place it near the up-take damper. It works independently of either of the two Controllers shown below. It does its part toward money saving by eliminating wasteful air infiltration.

The only requirement to make this money-saving plan workable is that you install the Control Units conveniently near the apparatus they operate — without panel board.

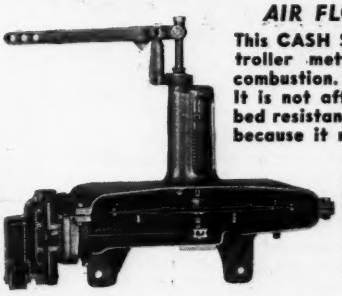
Since the Furnace Draft Controller works independently, you install it first for as little as $98. You add the rest of the system later to make it complete for one boiler.



You get Fuel Feed Controller, Air Flow Controller with Operating Power Cylinders included (as in the Furnace Draft Regulator), and necessary connecting fittings —all for as little as $290.

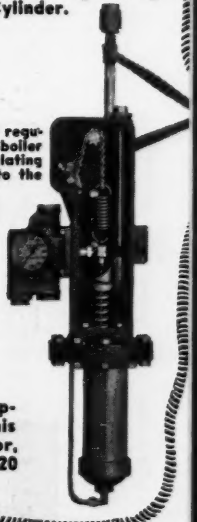
If you want Cash Standard Control System on panel boards, you can get them but we emphasize that the Control Units work just as well mounted individually elsewhere. Here you see a portable display panel on which full size Control Units (with miniature boiler) work automatically to show the real sensitivity, accuracy, and dependability of the Cash Standard System.

Get the complete facts — write for bulletin 963-A-B.



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion. Comes with Operating Power Cylinder.



FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving. Comes with Operating Power Cylinder.

OIL CIRCULATOR

The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate this equipment with this CASH STANDARD Oil Circulator, price $108 equipped with 110-220 v. 60 cy. motor.

A. W. CASH COMPANY

DECATUR, ILLINOIS

CASH STANDARD CONTROLS . . VALVES

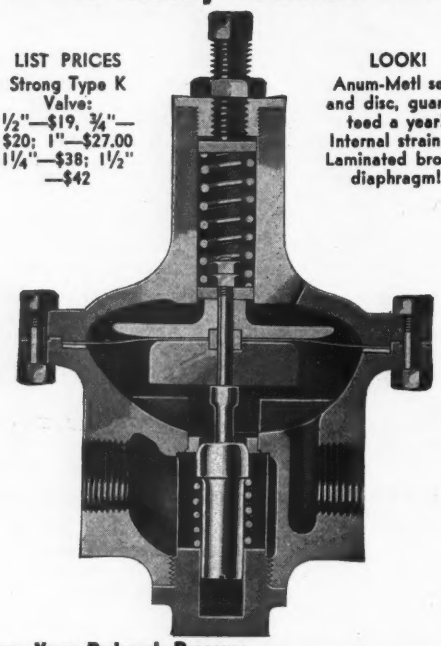
PIPEWRENCH PETE SAYS:

Here's A Medium Priced Reducing Valve That Works!

Single Seat and Disc, No Packing In This Husky STRONG Valve

LIST PRICES
Strong Type K Valve:
½"—$19, ¾"—$20; 1"—$27.00
1¼"—$38; 1½"—$42

LOOK!
Anum-Metl seat and disc, guaranteed a year!
Internal strainer!
Laminated bronze diaphragm!



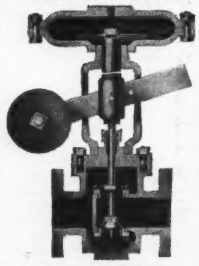
Name Your Reduced Pressure From 0 to 85 Pounds!

Here's the answer to accurate low-cost pressure reduction! Strong's Type "K" Reducing Valve, with its Anum-Metl seat, internal strainer, and simple, self-contained mechanism is ideal for reducing power steam to pressures you can use for heaters, cookers, driers, etc.

Adjusting spring holds valve open until reduced pressure reaches point desired. Outlet pressure then raises diaphragm against action of spring, closing valve, and completing cycle.

Write about your pressure reducing problems or for Catalog 154-PE-11.

BALANCED TYPE



Strong Type "B" For inlet pressure to 125 lbs., giving reduced pressure from 30 lbs. to 5 lbs. below atmosphere.

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

STRONG
STEAM SPECIALTIES

lower than the corresponding rate for joints on untested cable.

There has been a downward trend in the number of high potential tests made during the past four years. Of the 3477 tests made during 1938, 20 per cent were made with a.c. potentials and 80 per cent with d.c. potentials. The average ratio of test to operating voltage was 1.5 for a.c. test voltage with a maximum ratio of 3.1 and a minimum ratio of 1.0. For d.c. test potentials this ratio was 4.0 with a maximum ratio of 6.3 and a minimum ratio of 1.6. Approximately one out of every 15 tests produced a cable, joint or pothead failure.

For the first time since the Committee started gathering data on removals the trouble rate on solid-type paper-insulated cable with joints connected to oil reservoirs is 2.8 per cent lower than for cables without oil reservoirs. The joint trouble rate on joints connected to oil reservoirs was 52 per cent lower than for joints not so connected.

Data submitted by the Electrical Testing Laboratories covering the assigned causes of 787 cable troubles shows that approximately one-half were assignable to one of four causes, namely: initially defective sheath, deterioration in cable over ten years old, sheath corrosion and external mechanical damage. These four causes accounted for 13, 7.2, 19 and 8.9 per cent, respectively, of all cable troubles.

Copies of the complete report can be obtained from The Edison Electric Institute, 420 Lexington Ave., New York, N. Y., at a price of 60 cents to members of the Institute and their employees, $1.50 to nonmembers in the U. S. A. and $1.60 to foreign countries.

Safety in the Power Plant

CARELESSNESS cannot be tolerated in industry because it results in the loss of life and money. There was a time when a worker was injured or lost his life in the course of his work it was his own responsibility but as our social order developed and industry became mechanized laws were passed making the employer responsible, if not entirely at least to a considerable extent. As a result of such legislation and with a better perception of the rights of workers, employers effected measures for the protection of workers and installed safety devices of various kinds.

But safety devices alone do not necessarily prevent accidents. Unless the worker himself is conditioned to the dangers inherent in the operation of machines and power driven equipment, accidents will occur despite the best of safety devices. Strangely enough, the greatest number of accidents result not from the use of obviously dangerous equipment but from the use of apparently harmless devices. More people are killed by contact with comparatively low voltage circuits in electrical work than from high voltage circuits which are known to be deadly.

Continued on Page 136

Controlled Multicyclones Assure 90% Fly Ash Collection at ALL Loads

You have a right to demand repeated and many test results on the size unit you consider purchasing before you accept a manufacturer's guarantee of dust collection efficiency.

The guarantee of 90% overall collection on pulverized fuel dust by means of Thermix Controlled Multicyclones is so unprecedented with mechanical collectors, that Prat-Daniel engineers have anticipated your demand. Furthermore, the tests are not made on laboratory sized units, but on the actual size units offered to you. As many of the tests as possible have been witnessed and checked by prominent independent engineers.

The patented control feature of Thermix Multicyclones is essential to high efficiency at varying loads to maintain efficiency at low loads, since centrifugal force decreases at the square of the load. A cyclone without control, which is operating at even 70% of its maximum load, has only (.70 X .70) 49% as much centrifugal force. At 50% this drops to 25%. Multiple cyclones without control will not give the results required except at one load.

For small space, Thermix Tubular Dust Collector is indicated, or Thermix Recirculator if draft is required at the same time.

Ask for proofs by tests. Write for catalog.

PRAT-DANIEL CORPORATION

82 So. Water Street, Port Chester, N. Y.
Representatives in all important cities

THERMIX Controlled MULTICYCLONE

YES, the new G-E Diactor generator-voltage regulators are topping the performance of the popular Type GDA units. Such improvements as fewer moving parts, stronger and lighter construction, faster action, and a new fully enclosed design to prevent the entrance of dust and dirt have made it possible.

All Diactor regulators have the same quick-action, wide-range rheostatic element that made Type GDA regulators such outstanding performers. It's the only element that provides an infinite number of smooth resistance steps from practically zero to the maximum—and the regulation curve is correspondingly smooth.

Now a Complete Line—Six Ratings

G-E Diactor regulators are available in six different ratings—for generators rated 18,750 kva at 3600 rpm and smaller machines at correspondingly lower speeds. The midget of the line is for machines of 31.3 kva and smaller. A specialist in the nearest G-E office can give you detailed information. Or write for Bulletin GEA-2022C. General Electric, Schenectady, N. Y.

DIACTOR REGULATOR ADVANTAGES

Direct Acting — therefore fast in operation

No Vibrating Contacts — means reliable operation, reduced maintenance, and longer life

Electrically Damped — no dashpots or other mechanical antihunting devices to cause trouble and require maintenance

All Parts Normally Stationary — greatly decreases friction and wear

Small, Compact — saves switchboard space

Simple Construction — easy to understand and operate —only six leads required

No Auxiliary Relays — permitting operation directly in exciter-field circuit

GENERAL ELECTRIC

In every industry, therefore, it is necessary to acquaint the workers with the hazards of their jobs and to train them in the safe use of their tools and devices which they use. When men are hired, the supervisor or foreman should explain in detail the particular hazards involved in his work and make him realize that danger is always near. Knowing this, it is part of the worker's job to be cautious and careful so that this danger will not be effective in causing injury or death either to the worker himself or to his fellow workers.

Tools

Most important in keeping accidents at a minimum is the proper care and handling of tools. In an organization of any size, the tool keeper should be vested with the entire responsibility of maintaining the tools in good condition; furthermore, he should make certain that the person requesting a tool is capable of using it without injury to himself or co-workers. He should be sure all shock tools with bad head are dressed before they are issued. It is wise also to keep all sharp edged tools keen as a dull tool is likely to cause injury in its use. It must be remembered that any tool which is improperly tempered is not safe for the job.

Many injuries will be avoided if pipe wrenches are properly used. Always push or pull a pipe wrench in such a manner that the open end is facing the same direction as the force applied. Use the right wrench for the job and make sure it is in perfect condition. It is never advisable to use an extension on a wrench. The bite of an adjustable wrench should be taken near the middle of the jaws so that there will be teeth in front in case the wrench slips. The teeth should always be kept sharp.

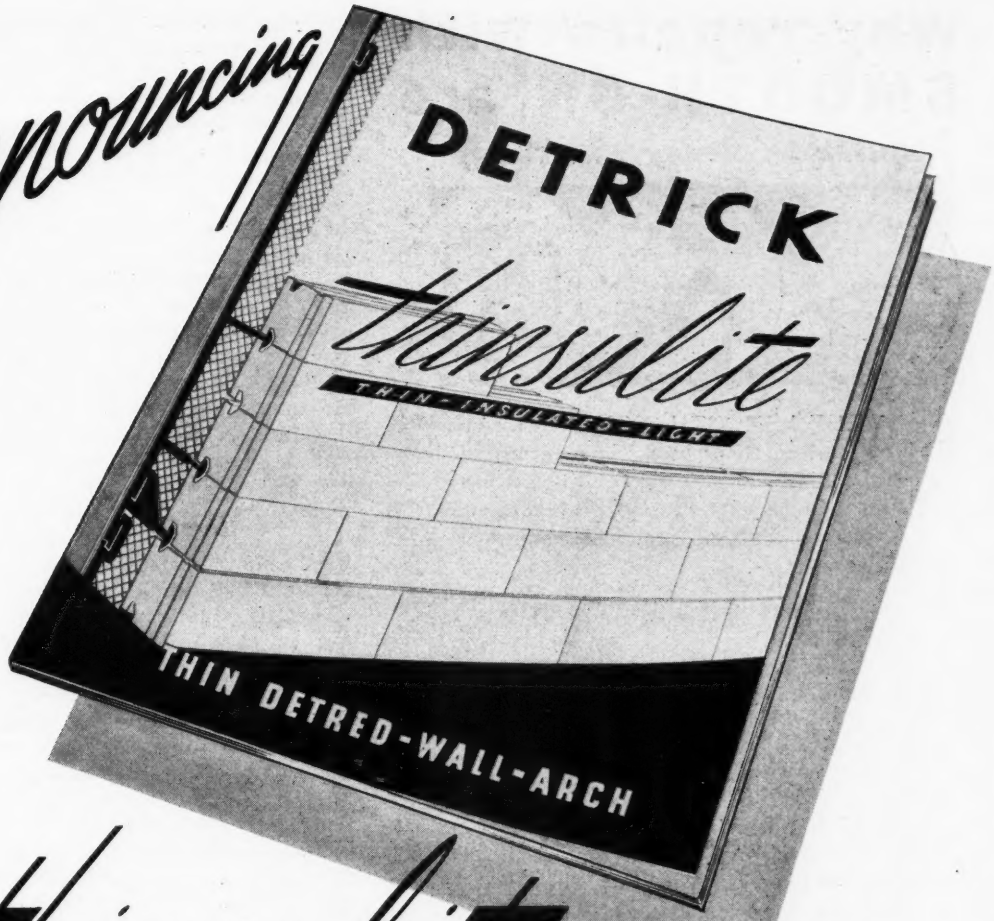
Sharpening hand tools is important and requires care; therefore it is well to use the proved safe method of sharpening them. When using the grinding wheel wear goggles and use a guard. The wheel should revolve away from the man using it. The tool being sharpened is held firmly with one hand and guided with the fingers of the other. Never use a dirty oil stone or a dry one. An oil stone may be cleaned by placing it in a pan and heating it and then wiping it dry and clean while hot.

Piping

Several precautions taken in steam fitting are necessary to ensure safety. The first thing to remember is to keep the tools in their proper places so that they will not become stumbling hazards or fall and injure someone. When threading or when backing off the cutting die make certain that the stock is held firmly in the vise. Protect the new threads by using a cap or coupling. When carrying pipe the forward end is held up to clear the heads of other persons. Lock all control valves before working on them. Pipes containing chemicals, gas, steam, air or water under pressure should be drained or bled if they are to be worked on. When working on a particular piece of equipment the safe practice to employ is to disconnect and remove a section of the pipe leading to the equip-

Continued on Page 138

Announcing



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THIN—INSULATED—LIGHT

New Detrick

SUSPENDED

Walls and Arches that compete with Solid Wall Construction!

By combining thin refractories . . . insulation . . . and the Detrick SUSPENDED tile principle, we can now offer Detrick efficiency at a first cost that definitely competes with solid wall construction.

Complete *suspended* enclosures are now possible, using THINSULITE construction in combination with the regular Detrick DETRED construction in the hotter zones. Suitable for Boiler Walls, Water Wall Backing, Oil Still Furnaces, Stress Relieving Furnaces . . . in fact, all areas not exposed to actual abrasion. Advantages are: low material and labor cost . . . light weight . . . low heat loss . . . permanent heat tight and air tight structure . . . and therefore low maintenance cost.

Be sure to get your copy of this new Detrick THINSULITE Catalog . . . free on request . . . showing construction, applications and heat transfer curves on this new Detrick engineering achievement.

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Made by **DETRICK**
For every Heat Insulation requirement Detrick offers many distinct advantages.
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CONSULT US ON INSULATION PROBLEMS
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Why repairs with SMOOTH-ON are

quick . . . easy . . . cheap

WHEN SMOOTH-ON No. 1 is used to seal cracks or breaks in pressure vessels, to stop leaks at joints, or to tighten loose machine parts, the repair is lasting, and withstands vibration, heat and temperature changes.

The SMOOTH-ON method is *quick,* because disassembling of equipment is unnecessary. It is *easy,* because no heat, special tools, or previous experience are required. It is *cheap,* because SMOOTH-ON costs so little and saves so much.

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ment and blank off the dead ends. If this method is impracticable a slip blank may be inserted at the most suitable joint in each pipe. It is well for men working in the plant to familiarize themselves with the standard color code of piping. "F" designates fire protection materials and equipment and the color is red. Dangerous materials are designated "D" and the color is either yellow or orange. Safe materials are colored green, white, gray or aluminum and are designated with the letter "S". Protective materials are colored blue and designated with the letter "P". Deep purple is the color of valuable materials and the letter "V" is used.

If an open flame is used to thaw frozen pipes inside of a building it may cause a fire or its sudden heat might break the pipe and flood the premises; therefore this method should never be used. The safe way is to use hot water. This is done by first wrapping the pipe with cloths and then pouring the hot water upon it until the ice gives way.

Machinery

Machinery guards play an important role in the prevention of accidents in the shop. The addition of guards is effective in protecting the life of the worker when using dangerous power drive equipment but it is necessary for every worker to be sure that all guards are in place and in good condition. If a guard is broken or misplaced notify the supervisor immediately. This will save you and your fellow workers possible injury.

The cleaning of machine parts carries some danger, therefore care must be taken as to the use of the proper cleaning agents and equipment. Nonflammable fluids should always be used, as the danger of fire is always present.

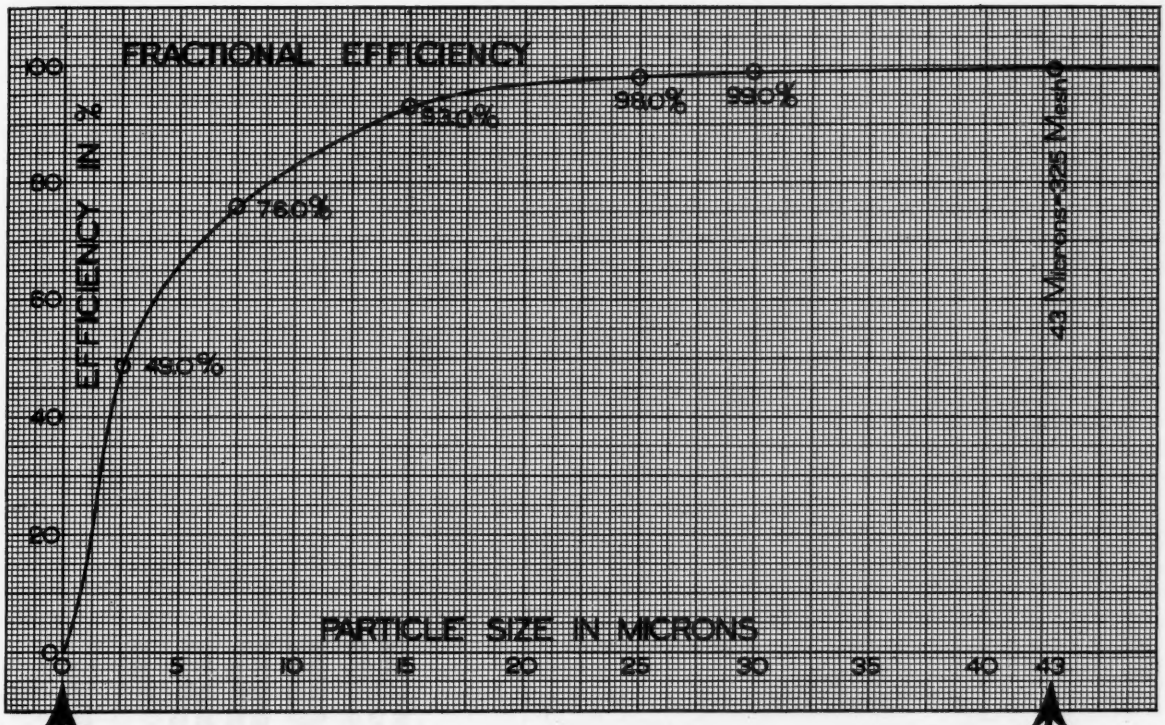
In concluding, the best practices to follow are: Do the job the safe and practical way; consider the other man's position as well as your own; never tackle a job which you are not capable of doing without injury to yourself or someone else; look over the conditions in your plant and make worthwhile suggestions to the man in charge. This will make your plant a safer and better place to work.

A NEW permanent-magnet assembly, roughly three times as strong as any previously known, permits a tiny piece of sintered Alnico to lift and hold 4450 times its own weight.

The previous record mounting, developed in the laboratory last year, allowed a piece of the same material to lift 1500 times its own weight. Sintered Alnico is an alloy usually consisting of aluminum, nickel, iron, and cobalt made by pressing together the powdered metals and heating almost to the melting point.

A new mounting of brass and iron in which the magnetic flux passes through many air gaps, instead of the usual two, in bridging from pole to pole, is responsible for the greatly increased power. The new assembly is not a commercial development and the largest turned out in the laboratory to date contains but three cubic centimeters of Alnico.—G. E. Review.

EVERY DUST COLLECTOR HAS A CHARACTERISTIC EFFICIENCY CURVE



THIS PART OF THE CURVE DETERMINES OVERALL EFFICIENCY

It's the dust *smaller* than 44 microns—dust that passes through the finest commercial screens—that is hard to collect. Yet "overall efficiency" (a much abused term) cannot be determined until the exact percentage of collection for each particle size between 0 and 43 microns is known.

Buell bases its guarantees for dust collection and fly ash correction on FRACTIONAL EFFICIENCIES. Buell guarantees the exact percentage of each dust particle size that will be collected, and *these guarantees hold regardless of changes in particle size frequency* that affect overall efficiency.

The Van Tongeren System used exclusively in Buell equipment offers outstanding advantages in efficiency, low first cost and guaranteed performance. Investigate Buell and save money.

Only Buell Cyclones have a Dust Pocket

Send for this
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"Fractional vs. Overall Efficiency Guarantees" is an 8-page bulletin explaining the importance of particle size analysis in determining dust collection guarantees. A copy is yours for the asking.

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DUST COLLECTORS

16 CEDAR STREET, NEW YORK

BUELL ENGINEERING COMPANY, INC.

Wherever located, you will be quickly served through sales offices of either BUELL ENGINEERING CO. or B. F. STURTEVANT CO.

New Engineering Books

Engineering Materials. By Alfred H. White. First Edition. 548 pages, 200 illustrations. 6 by 9 in., cloth. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1939. Price $4.50.

While this book is intended primarily as a text for engineering students, there can be no question about its usefulness to practicing engineers. The engineer of today is faced with a bewildering variety of materials which he must use in his work. The simple conception of steel held by a past generation, for example, has been complicated by considerations of grain size, hardenability, and heat treatment, and the many varieties of alloy steels have multiplied the number of materials available enormously. The plain portland cement of several years ago has been split into several specialized varieties. The old white lead and linseed oil have been supplemented by new products that refuse to fall into older classifications. The boiler plant seems to demand the ministrations of a dietitian rather than a brawny stoker.

This book presents up-to-date information on modern materials used in engineering in a form that will assist engineers in selecting suitable materials for certain purposes. The author is professor of Chemical Engineering and Chairman of the Department of Chemical and Metallurgical Engineering at the University of Michigan. His treatment of the subject is systematic and no knowledge of organic chemistry on the part of the reader is assumed.

The book is one that can prove useful to every engineer whether his work is concerned with design or operation and maintenance.

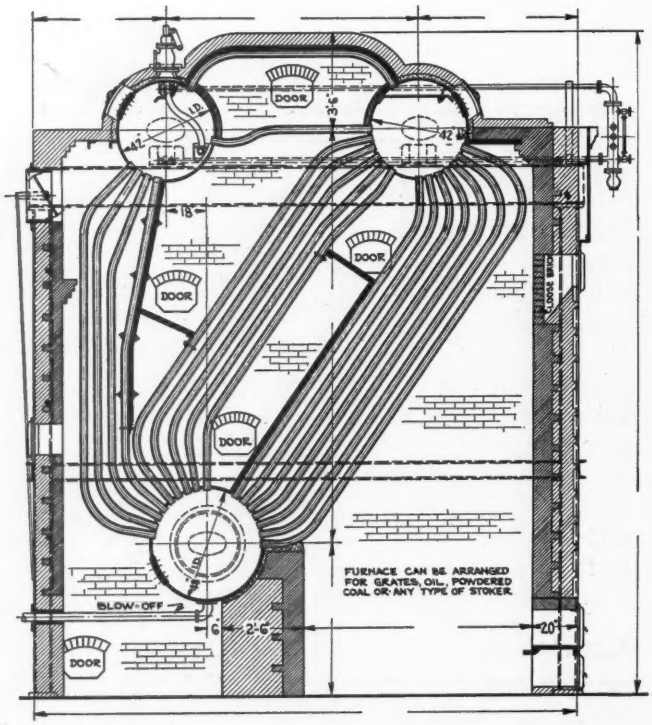
A Survey of the Science of Heat Transmission is published as Bulletin No. 68 by the Engineering Experiment Station, Purdue University, Lafayette, Ind. This is a 55 page, planographed, series of lectures presented by Dr. Max Jakob. The bulletin is free to residents of Indiana and a limited number of free copies are available to non-residents. After these are exhausted there will be a charge of 25 cents a copy to non-residents.

Power Economics for Engineering Students. By R. C. Gorham. Published by The Symonds Co., 1003 Investment Bldg., Pittsburgh, Pa. Size 5½ by 8½ in., cloth bound, 282 pp. Price $3.25.

Nowhere does the engineer tread on less secure footing than in the selection of equipment on a competitive price basis where engineering principles must be tempered with economic considerations. While the principles of economics involved are in themselves simple, practical application in engineering problems is often difficult. This book is aimed at the practical correlation of the two fundamental fields and the 22 chapters are divided into two parts. Part A is intended to justify a course in economics for engineering students; to set forth fundamental concepts; and to provide factual information with general principles which are applicable to engineering practices for best overall economy. Part B is intended to furnish opportunity for the application of principles which have been set forth in Part A.

This has been done largely through examples dealing with economic considerations of such factors as power station location and design; fuels; load division; size of electrical conductors; economic voltages; selecting power factor equipment, etc. While the problems deal mostly with public utility engineering the principles involved are applicable to any power problem. The author, associate professor of electrical engineering at the University of Pittsburgh, has developed the book largely from 8 yr. experience teaching a course in economics for junior and senior engineering students at the university.

Combustion, 1939, published by the Edison Electric Institute, 420 Lexington Ave., New York, N. Y., is a 44 pp., 8½ by 11 in. report of the Prime Movers Committee. It covers operating company and manufacturers statements on pulverized fuels and furnaces, combustion control, flyash collectors and ash handling, and mechanical draft equipment. Copies can be obtained from the Institute. The price is $2.00 per copy for non-members in the U. S. A.



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are characterized by extreme simplicity of design, high velocity, unrestricted and positive water circulation. These boilers are so flexible in operation that high ratings are obtained without danger of expansion and contraction stresses.

The boiler is especially designed to allow front, side and rear water wall coverage, and superheat installations are readily adaptable.

A boiler of this type can be designed to suit your particular conditions.

MURRAY IRON WORKS COMPANY, BURLINGTON, IOWA.

Heating, Ventilating, Air Conditioning Guide—1940. Published by the American Society of Heating & Ventilating Engineers, 51 Madison Ave., New York, N. Y. Size 6 by 9 in.; flexible fabrikoid; 1184 pages; illustrated. Price $5.00; with special thumb index $5.50.

A reference manual for the profession and industry, now in its eighteenth ediition, issued annually and devoted exclusively to the subjects of heating, ventilating and air conditioning and related data on refrigeration. Arranged in two sections—a Technical Data Section of 46 chapters and 792 pp. and a Catalog Data Section on manufacturers' equipment.

This new volume is less bulky and lighter in weight than previous editions, due to condensation and consolidation of text matter, and the use of lighter paper. Although there has been addition of much new data in old chapters and one new chapter, the result is a volume actually containing more information, but easier to handle and more convenient to use. A chapter index and a detailed subject index give ready reference to the technical data.

Gas and Oil Engines. By P. S. Caldwell. Published by Chemical Publishing Co., Inc., 148 Lafayette Ave., New York, N. Y. Size 4 by 6 in.; cloth bound; 121 pp. Price $1.50.

This book is divided into fifteen chapters. It is a practical handbook for the operating engineer and the student, covering briefly the theory and construction of engines and, in greater detail, the installation, operation, repair, troubles and remedies, use of the indicator, methods of testing, and calculation of test results.

Standard Combustion Control Specifications. By Richard H. Morris. Published by Technical Publishing Co., 53 W. Jackson Blvd., Chicago, Ill. Size 8½ by 11 in., 35 pp., paper bound. Price $1.00.

A detailed discussion of specification writing and requirements with special reference to automatic combustion control. The book is divided into six chapters, outlining: common control nomenclature; plant requirements for different fuels and operating condtions; various auxiliaries and auxiliary drives; and a complete detailed specification for a hypothetical plant. The standard specifications given are applicable to all types of plants, auxiliaries and fuels.

Production Management. By A. M. Simons and Henry Post Dutton. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½ by 8½ in., cloth bound, 588 pages. Price $3.50.

Production management is a broad field, difficult to define accurately for it covers all phases of industry from the location and erection of plants, research, making and using of machinery, transportation, power and every phase which requires effective organization and direction of human effort toward utilization of the materials of nature. The organization of this field into a single book written so as to interest, and be of value to, every one in industry from the newest worker to the top executive, was a task of no mean magnitude and has been admirably accomplished.

The 32 chapters cover in detail all phases of management, in many cases with organization charts and forms for specific needs. Some of the chapter headings include: location of an industry; planning the plant; purchasing and stores departments; organization of management; scheduling and control of production; office organization and management; drafting, tool room and inspection; shipping and packing; wages; training methods and principles; transfer, promotion, rating and personal records; leadership in industry; building departments within a business; executive authority and responsibility; principles and tests of good business organization.

The first author is with the Bureau of Medical Economics and was formerly lecturer on Personal Relations, University of Wisconsin; the second is professor of Business Management and dean of the Evening Division at Armour Institute and Professor of Factory Management at Northwestern University.

Industrial Surveys and Reports. By Walter Rautenstrauch. Published by John Wiley & Sons, Inc., New York, N. Y. 6 by 9 in., 189 pages. Price $2.50.

Some of the problems engineers encounter in investigating and reporting on the operations of industries are outlined in this textbook. The subject matter was evolved from the author's own experience. A report embodying the results of investigating a particular company is given which is typical of the kind of reports made to assist investment bankers to arrive at a judgment on underwriting the securities of the company.

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Interior Electric Wiring and Estimating. By Albert Uhl, Arthur L. Nelson and Carl H. Dunlap. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½ by 8½ in., 337 pp.; cloth bound. Price $2.50.

This is a new and enlarged edition of a book first published in 1929. It starts with the fundamental and in a step by step manner works into the higher stages including estimating, department and factory building wiring. No previous knowledge of wiring is assumed and the arrangement and contents of the book makes it of value to beginner, experienced wiremen, contractors, students and architects. It contains 332 illustrations, 41 tables, 8 full size blueprints drawn to scale and over 50 questions with the answers worked out in detail.

Proximate Coal Analyses. Districts No. 8 and 9. Published by National Coal Publications, Law Bulletin Building, Pittsburgh, Pa. (See original review for District No. 2, p. 757, November.) The analyses data contained in these books is an exact copy of the analyses filed with the National Bituminous Coal Commission by the District Producers Boards. Separate volumes are now available for the following Districts: No. 1, Central, Pa.; No. 2, Western Pa.; No. 3, No. W. Va.; Nos. 4, 5 and 6, O., Mich., and the panhandle of W. Va.; No. 7, So. low volatile: No. 8, So. high volatile; and No. 9, W. Ky. Additional volumes will be available within the next few weeks covering the following Districts: No. 10, Ill.; No. 11, Ind.; No. 12, Iowa; No. 13, Ala. and parts of Ga. and Tenn.; No. 14 Ark. and Okla.; and No. 15, Kans., Mo., Tex. and part of Okla. All volumes are listed at $10.00 per copy (with a 50 per cent discount to subscribers to, or advertisers in, MacQuown's Coal Directory and Buyers Guide) except No. 9 which lists at $5.00 per copy.

Pipe Specifications. A.S.T.M. Specifications for pipe and piping materials for high-temperature and high-pressure services have been combined in a single 137 p., 6 by 9 in. spiral bound book with stiff paper covers. Twelve of the 23 specifications cover various types of carbon and alloy steel pipe and boiler tubes, etc., including classification and dimensions of wrought iron and wrought steel pipe. Carbon and alloy steel castings for valves, flanges and fittings are covered in four of the specifications and forged or rolled alloy steel pipe flanges in three other standards. Three of the specifications pertain to alloy steel bolting materials and carbon and alloy steel nuts. An important addition is the standard on classification of austenite grain size in steel with two grain size charts. Copies are available from A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, at $1.25 each with special prices on orders for ten or more.

Machine Shop Work. By Frederick W. Turner and Oscar E. Perrigo. Fifth edition revised by Aldrick Bertrand. Published by the American Technical Society, Chicago, Ill. Size 5½ by 8½ in., 408 pp. Price $2.75.

The fifth edition of this popular book has been thoroughly revised. It is a practical, written in a clear and easy-to-understand manner covering: approved shop methods; construction and use of tools and machines; details of their efficient operation; and, modern production methods. As such it is ideal and for use in vocational, trade and apprentice training classes as well as for individual study because it includes information every man who works in a machine shop should know, with 444 photographs and line drawings, 27 tables and a complete index.

Public Speaking for Technical Men. By S. Marion Tucker. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York City. Size 5½ by 8½ in., cloth bound; 394 pages. Price $3.00.

Engineers and technical men have a general reputation as poor speakers, a reputation not altogether undeserved. While they can hardly be expected to be orators, with the ability to make an extemporaneous speech on any subject regardless of the occasion, an audience which spends several hours to hear a paper or lecture by an engineer on some subject in his own field, is not unreasonable when it expects the presentation to be well arranged, clear cut and direct, with the illustrations or slides properly prepared and intelligible.

Dr. Tucker, who is Professor of English and Head of the Department of English and Psychology at the Polytechnic Institute of Brooklyn, has in past years rendered valuable assistance at meetings of the A. S. M. E. by

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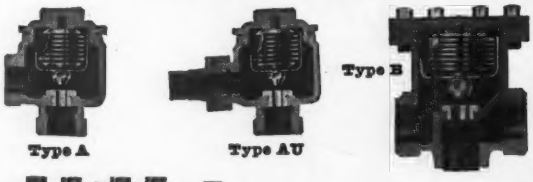

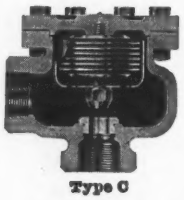

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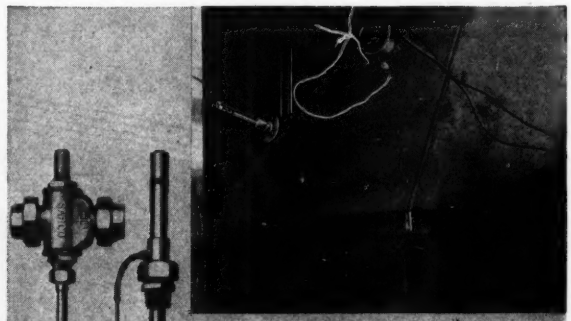

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holding special short classes for the speakers. This book is a continuation of his work along that line and is one with which every engineer and technologist who is called upon to present technical papers or take part in company or staff meetings should have and be familiar with.

While covering such subjects as dictation, organization of material and platform technique, an important part of the book is the practical suggestions for the technical speaker on the proper use of the blackboard, charts and exhibits; the use of mimeographed material; the use and preparation of lantern slides; and how to meet interruptions and answer questions. Effective public speaking can be learned only by practice, but, with this book as a guide, any engineer, who knows his subject, should be able to organize his material and prepare his talk with sufficient confidence to allay fears of appearing before an audience, large or small.

The Edison Electric Institute, 420 Lexington Ave., New York, N. Y., has recently issued the following publications:

No. G4, Electric Metal-Melting Furnaces. 36 pages. A report of the Industrial Power and Heating Committee of the E. E. I. Price 80c to members of the Institute and their employees, $2.00 to non-members in the U. S. A. and $2.15 to foreign countries.

G5, Cable Operation 1938. 36 pages. A report of the Transmission and Distribution Committee of the E. E. I. Price, 60c to members of the Institute and their employees, $1.50 to non-members in the U. S. A. and $1.60 to foreign countries.

E. E. I. Publication No. G6 or N. E. M. A. Publication No. 106. Standards for Distribution Transformers. A 12 page report of the joint committee of the E. E. I. and N. E. M. A. on Standards for Distribution Transformers. Price, 25c to members of either organization and their employees, 60c to non-members in the U. S. A. and 70c to foreign countries.

Legal Aspects of Engineering. By Walter C. Sadler. Published by John Wiley & Sons, Inc., New York City. Size 6 by 9 in., 613 pp.; cloth bound. Price $4.00.

Law is something which the average engineer prefers to leave to someone else, yet it is something that cannot be entirely neglected by those engineers concerned directly with the purchase of equipment or with contracts and to a smaller group law is quite as important as their engineering duties. In the light of all this it is surprising to find the author has combined law and engineering into a very interesting book. No attempt is made to turn the reader into a professional lawyer, but to give a general understanding of certain pertinent branches of law, the philosophy of legal principles and their application to his business.

The material is presented as case studies of some 300-odd cases selected from over 6500 dealing with engineering problems. Each is analyzed carefully and summarized and the arrangement is such that those dealing with specific problems may be located without difficulty.

Public Buildings. By C. W. Short and R. Stanley-Brown. Published by the Government Printing Office, Washington, D. C. Size 8½ by 11½, 688 pp., cloth bound. Price $2.50.

This book is a detailed study of the architecture (with floor plans) of 620 P.W.A. building projects selected from the 26,000 built between 1933 and 1939. As such it serves as a comprehensive survey and reference of representative architecture and design of public works during this 6 yr. period. The architectural sections are preceded by a 23 pp. section, outlines the scope of the studies, P.W.A., regions, policies and accomplishments. Both authors are with the Public Works Administration and the book was authorized by John C. Carmody, administrator of the Federal Works Agency.

How to Design and Install Plumbing. By A. J. Matthias, Jr. Published by American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½ by 8½ in.; 382 pp; cloth bound. Price $3.00.

While plumbing may be only of minor interest to power plant engineers, it is an important and essential part of the duties of the master mechanic, plant engineer or manager of many industrial plants. This is a thoroughly practical book, covering all phases of plumbing, hot and cold water systems, drainage, etc., written so as to be of value to the plumber who must do the work as well as to those responsible in a more general way for the design or layout, proper operation and maintenance of plumbing systems.

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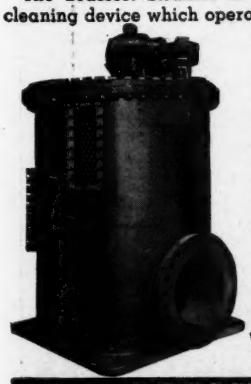

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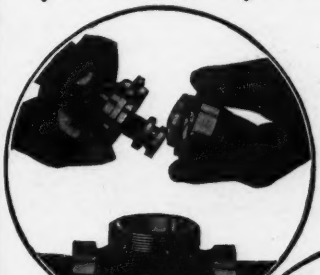

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Power Plant Construction News

Calif., San Diego—Consolidated Gas & Electric Co., San Diego, is closing arrangements with city Board of Harbor Commissions for 50-year lease on tract of tideland property at foot of Ninth Avenue, as site for new steam-electric generating station. Proposed station will be built in three main units, each to cost about $3,000,000 with turbine-generators, high-pressure boilers and auxiliary equipment. Work on first unit is scheduled to begin this year.

Colo., Denver—Bureau of Reclamation, Denver, will receive bids until April 15 for four 25-ft. dia. welded plate-steel penstocks, varying from 100 to about 250 ft. in length, for Parker hydroelectric power plant, Parker dam power project, California-Arizona (Specifications 898).

Conn., Portland—Robert Gair Co., 155 East Forty-fourth Street, plans boiler house at new corrugated container manufacturing plant at Portland, near Middletown, Conn., where tract of 8 acres of land has been acquired. Plant will total about 80,000 sq. ft. of floor space. Electric power equipment will be installed in production divisions. Entire project is reported to cost over $125,000. Mylchreest & Reynolds, 238 Palm Street, Hartford, Conn., are architects and engineers.

D. C., Washington—Public Buildings Administration, Ninth and D Streets, S.W., Washington, is securing an appropriation in current Federal budget of about $3,900,000 for new power plant on local site for central-heating service, to be known as West Central heating plant.

Ind., Columbus—Noblitt-Sparks Industries, Inc., Seventeenth Street, plans installation of electric power equipment in new addition to plant for expansion in metal stamping division. Entire project reported to cost over $60,000. Proposed to carry out work this spring.

Ind., Kokomo—Continental Steel Co., West Markland Avenue, plans installation of electric power equipment in new addition to plant, one-story, about 67 x 140 ft. Entire project is estimated to cost over $65,000. Work will begin soon. L. H. Mandville is company engineer.

Ill., Marseilles—City Council has plans under way for new municipal power plant. Cost estimated close to $200,000, with equipment. Samuel R. Hunter, 608 South Dearborn Street, Chicago, Ill., is consulting engineer.

Ill., Rockford—West End Furniture Co., plans installation of electric power equipment in connection with rebuilding portion of plant recently destroyed by fire. Loss estimated over $300,000, including machinery.

Iowa, Cedar Falls—City Council has plans nearing completion for proposed municipal hydroelectric power plant at end of State Street, and will begin erection this spring. Clark N. Streeter is city engineer, in charge.

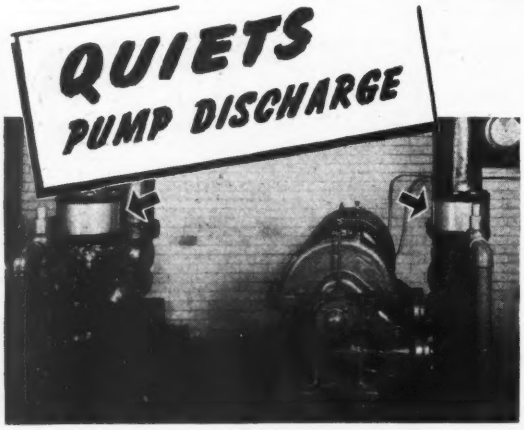
Iowa, Lone Tree—Town Council is considering a municipal power plant and proposes to carry out surveys and estimates of cost in near future. An engineer will be engaged for this purpose. It is proposed to use Diesel engine-generating units and accessories.

Kan., Abilene—Kansas Power & Light Co., Topeka, Kan., is considering extensions and improvements in steam-electric generating station at Abilene, including installation of additional equipment. Cost reported over $1,000,000, with equipment. This will be part of 1940 expansion program of company.

Kan., Clay Center—City Council has plans maturing for extensions and improvements in municipal power plant, including installation of equipment. Estimates of cost are being made. Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City, Mo., is consulting engineer.

Mich., Flint—A.C. Spark Plug Division, General Motors Corporation, plans installation of electric power equipment in new local two and four-story plant, about 250x500 ft. Work is scheduled to begin soon. A central-heating plant is planned. Entire project will cost close to $1,500,000. L. Clifford Goad is president and general manager.

Mo., Brookfield—Missouri Power & Light Co., Kansas City, Mo., will carry out expansion and improvements in



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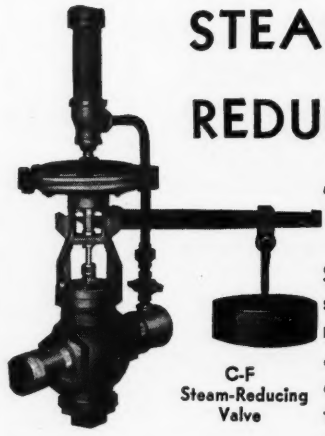

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steam-electric power plant as part of 1940 expansion program, including installation of new 5000-kw. turbine-generator unit, boiler and auxiliaries. Cost is estimated close to $500,000.

N. J., Newark—Public Service Electric & Gas Co., Public Service Terminal, has plans under way for new electrical testing laboratory and station in Irvington district, reported to cost over $300,000, including equipment. F. P. Fairchild is company engineer in charge.

N. Y., Niagara Falls—E. I. duPont deNemours & Co., R. & H. Chemicals Department, Buffalo Avenue, plans installation of electric power equipment in connection with expansion and modernization in local plant, for which an appropriation of about $400,000 has been authorized. Work is scheduled to begin soon. Main offices of company are in duPont Building, Wilmington, Del.

Ohio, North Baltimore — France Stone Co., Second National Bank Building, Toledo, Ohio, plans complete electrification of plant near North Baltimore. Contract for power supply has been made with Central Ohio Light & Power Co., Findlay, Ohio, which will extend transmission to new power substation at plant site.

Ohio, North Baltimore — Village Council has plans nearing completion for proposed municipal power plant, with installation to include two 450-hp. and one 375-hp. Diesel engine-generator units and accessories. Cost about $195,000. Work is scheduled to begin as soon as Court permission has been secured. C. J. Simon, Evans Central Building, Van Wert, Ohio, is consulting engineer in charge of this work.

Ohio, Painesville—Industrial Rayon Corporation, East Ninety-eighth Street and Walford Avenue, Cleveland, Ohio, plans installation of electric power equipment in new multi-story addition to branch plant near Painesville, for large increased capacity. Power facilities at mill will be expanded. Entire project reported to cost over $2,500,000. Wilbur Watson & Associates, 4614 Prospect Avenue, Cleveland, are engineers.

Ore., Tongue Point — Bureau of Yards and Docks, Navy Department, Washington, D. C., plans call for bids in April for euipment for power plant at Tongue Point, including electrical distribution lines (Specifications 9484).

S. C., Pickens — Poinsett Lumber Co., Pickens, affiliated with Singer Sewing Machine Co., Elizabethport, N. J., plans installation of electric power equipment in new local mill for production of cabinets for last noted company. Plant will comprise three main units, about 200x560 ft. Entire project will cost over $175,000.

Texas, Beaumont — Magnolia Petroleum Co., Magnolia Building, Dallas, Tex., plans installation of power equipment in connection with expansion at oil refining plant at Beaumont, for increased gasoline production. Entire project is reported to cost in excess of $600,000. Company is a subsidiary of Socony-Vacuum Oil Co., 26 Broadway, New York, N. Y.

Texas, Freeport — Dow Chemical Co., Midland, Mich., plans power house, pumping station and other mechanical operating departments at proposed new plant at Freeport, where tract of about 800 acres of waterfront property is being equipped. Electric power equipment will be installed in general plant units. Entire project is reported to cost over $4,000,000. Austin Co., 16112 Euclid Avenue, Cleveland, Ohio, is engineer, in charge of construction.

Texas, San Antonio—National Aircraft Corporation, Trinity Life Building, Fort Worth, Tex., plans installation of electric power equipment in two new additions to airplane-manufacturing plant on Gillette Boulevard, San Antonio, 150x300 ft., and 80x200 ft., respectively. Entire project will cost over $185,000. Work will be placed under way soon.

Wash., Aberdeen — Aberdeen Plywood Co., Aberdeen, plans new steam power house in connection with proposed rebuilding of local mill, recently destroyed by fire. Also will install compete power equipment and facilities for mill service. Fire loss totaled over $500,000.

W. Va., Huntington—International Nickel Co., 67 Wall Street, New York, N. Y., plans installation of electric power equipment in connection with expansion and improvements in branch mill at Huntington. A new furnace unit and other production equipment will be installed. Entire project is estimated to cost close to $125,000.

Wis., Kenosha — Nash-Kelvinator Corporation, Nash Motor Division, Twenty-fifth Avenue, plans installation of electric power equipment in new addition to local automobile plant on Thirtieth Avenue, 240x240 ft. Entire project is reported to cost over $175,000. Proposed to carry out work in spring.

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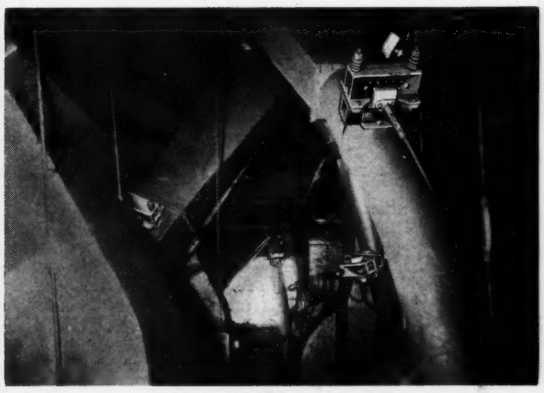

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General Coal Company
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Cash Company, A. W.
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Hagan Corporation
Hays Corporation, The
Republic Flow Meters Co.

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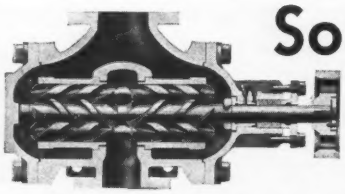

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The pipe line company which owns the portable IMO oil pumping unit here shown recently ordered a duplicate. Other repeat orders just received are fuel oil service, lube oil service and fuel oil transfer pumps for two more Maritime Commission ships, lube oil pumps for a turbine manufacturer, fuel oil service pumps for an oil burner manufacturer, lube oil pumps for a refinery, fuel oil pumps (a total of 18 by ones and twos in six years) for a gas company, etc., etc. De Laval-IMO oil pumps can be run at standard motor and turbine speeds. *Ask for Catalog I-58.*

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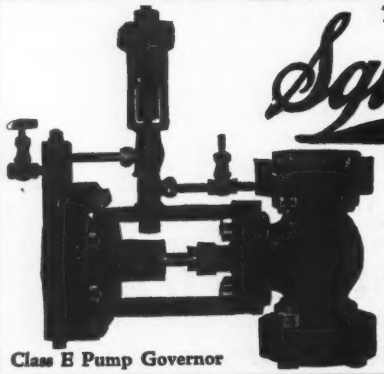

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